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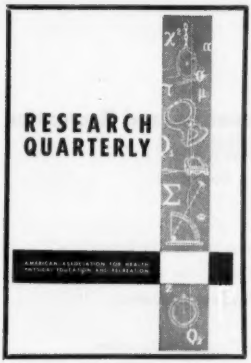

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Teleroentgenologic Investigations of Champion Turkish Wrestlers

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Abstract

Cardiac transverse diameter, heart rate, and arterial blood pressure were studied in 17 champion Turkish wrestlers. The wrestlers' cardiac transverse diameters were compared with eight normal untrained Turkish people, the Ungerleider-Gubner nomogram, and other reported values. Bradycardia and low arterial blood pressure were found in wrestlers. The mean transverse diameter of wrestlers was significantly larger than that of controls, but the same as the values found in normal people by others. The mean transverse diameter of controls was slightly smaller than the predicted values. It was concluded that wrestlers' cardiac transverse diameters are at the upper limits of normal values.

A SURVEY OF the literature pertaining to the effect of strenuous physical activity on the size of the human heart reveals much conflicting data. Some investigators say that the heart size of athletes is within the range for normal individuals of the same size and age. Some claim that the heart size of trained athletes is larger than that of similarly built untrained individuals. For example, Schieffer (35) and Dietlen and Moritz (11) reported heart areas in habitual cyclists to be greater than occasional cyclists or noncyclists of the same corresponding size and age. Deutsch and others (8, 9), after examinations of several thousand athletes of all kinds at the Vienna Heart Station and of 32 athletes at the 1928 Amsterdam Olympics, concluded that the heart shadow of trained athletes was larger than that of similarly built individuals who exercise for pleasure only. But these observers interpreted this enlargement of the heart as a dilatation brought on by vagotonia in athletes. Herxheimer (17, 18) reported primary hypertrophy in 171 participants in the German Games of 1922 (19), in 12 professional six-day bicycle racers (20), in three athletes, and in 249 Amsterdam Olympic athletes (21). Eimer (12) found similar results in 300 athletes. Bramwell (4) and Krestovnikov (26) reported the physiologic hypertrophy of the heart which is produced by regular training. Ackermann (1) measured hearts of the same oarsmen before and after a season of training. About half, mostly the younger men, showed definite enlargement at the end of the season. Roesler (34) studied four athletes orthodiagraphically and found that diameters of the heart are increased by training and reduced after stopping training. Debene (7) reported that the volume of the heart increases as athletes approach better physical condition. Zdansky (40), interested mostly in the types of athletes' hearts, found longitudinal enlargement of the left ventricle in athletes who engaged in strenuous sports. The findings of Nylin (27), Koepplin (25), Reindell (32), and Kirch (23) confirmed the enlargement of the athlete's heart.

On the other hand, Aschoff (2), Rautmann (29, 30), Dibbelt (10), Cohn (5), Podkaminsky (28), Farrel and others (14), Eyster (13), and others have reported that the heart size of athletes was not larger than that of untrained individuals of similar build and age. According to Bangou and others (3), the athlete's heart is not necessarily an enlarged heart. Rasch and others (31) investigated the effect of a work load of progressively increasing magnitude on the heart size of adult male rats and did not find any

evidence to indicate that increasing exercise produced cardiac hypertrophy. Wolffe (39) found wide variations between the actual and predicted transverse diameters and concluded that from a clinical point of view the so-called athletic heart appears to be only a myth. Cureton (6) even claimed that exercise may cause diminution in heart size.

Reindell and others (33) have done some radiologic, electrocardiographic, and hemodynamic investigations before and after effort of 850 athletes, concerning hypertrophy of the heart and whether a hypertrophied heart could produce circulatory disturbances. In these investigations, hearts generally became enlarged with exercise, for instance, in 37 of 40 cyclists, but this enlargement never produced circulatory disturbances. Furthermore, they found that, in long-distance running, cardiac hypertrophy generally depends on dilatation of cavities. This fact was explained by observations of marked diminution of volume of the heart during Valsalva maneuver immediately following effort. According to the authors, if there is hypertrophy in right or left ventricle, the heart should not become so much smaller during the Valsalva maneuver performed immediately after effort.

The results of investigations about heart enlargement carried out on the different types of athletes are conflicting. We have also noted that wrestlers are very seldom the subjects of this type of investigation.

This report presents the teleroentgenologic investigations of the effect of wrestling on heart size and the extent to which hypertrophy and dilatation account for this enlargement. As Wolffe (39) says, the roentgenologic shadow, despite minor changes in size depending upon phases of respiration and of cardiac cycle at the time of X-ray exposure, is rather valuable in estimating cardiac size and shape, and we also used teleroentgenography for our purpose. At the same time, we took heart rate and arterial blood pressure of wrestlers at rest.

We selected 15 champion wrestlers—among them several world champions —two coaches, and as a control, eight medical students and hospital personnel. If coaches are excluded, the youngest wrestler is 20, the oldest 30 years old. One wrestler has been wrestling from three to five years and the rest from six to ten years. One of them interrupted his wrestling for two years; the rest had not. The youngest of the controls is 22, the oldest 33 years old, and none has ever participated in any regular training. All subjects were healthy.

Method

All wrestlers and control subjects were examined under standard conditions in the morning. First, medical and athletic histories were taken and, secondly, arterial blood pressures and pulses were recorded. Heart teleroentgenograms were taken of each subject at the end of normal inspiration at rest. The distance from tube to film was 2 meters and the transverse diameters were measured to estimate cardiac enlargement (16). When there was enlargement, Reindell's (32) method for detecting the parts played by hypertrophy and dilatation was used. This consisted of measurement of the degree of diminution of the heart volume during the Valsalva maneuver immediately following effort. Then transverse and longitudinal diameters were measured at rest and after effort to estimate the degree of the diminution of the heart size. For this purpose, after teleroentgenography at rest, every subject performed work which consisted of stepping up and down onto a platform 45 cm. high 45

times in a period of 1½ minutes while carrying a 20 kg. sand bag on his back. Immediately after this effort they performed a Valsalva maneuver, and second teleroentgenograms were recorded during this maneuver. Teleroentgenograms were taken in the erect and dorso-ventral positions at the end of normal inspiration both at rest and after effort.

Results

Heart Rate and Arterial Blood Pressure. In the wrestlers the average pulse rate was 63 with rather low arterial blood pressure, as seen in Table 1. In the controls, the average pulse rate was 72, and systolic and diastolic blood pressures were similar to those of the wrestlers. The difference between wrestlers' pulse rate and that of the controls was statistically significant ($p < 0.05$).

Teleroentgenologic Findings. In the wrestlers, cardiac size was measured by the transverse diameter, which averaged 13.4 cm. (Table 2). The diminutions of the transverse and longitudinal diameters during Valsalva maneuver following effort were respectively 8 percent and 6 percent (Table 3). In the controls (see Table 2), the average value of the transverse diameter was 11.8 cm. The diminution of the transverse and longitudinal diameters during Valsalva maneuver following effort were respectively 7 percent and 5 percent.

TABLE 1.—HEART RATE AND BLOOD PRESSURE AT REST[a]

Subjects	No.	Heart rate/min.	Blood pressure/mm. Hg.
Wrestlers	17	63 ± 2.2	109 ± 2.5/73 ± 1.7
Controls	8	72 ± 3.8	103 ± 3.4/65 ± 2.8

[a] The difference between the heart rate of wrestlers and that of controls was significant ($p<0.05$).

TABLE 2.—TRANSVERSE CARDIAC DIAMETERS AT REST COMPARED TO THE UNGERLEIDER-GUBNER NOMOGRAM

Subjects	No.	Observed Transverse Diameter (cm)	Predicted Diameter: Ungerleider-Gubner Nomogram (cm.)
Wrestlers	17	13.4 ± 0.2	13.3 ± 0.2
Controls	8	11.8 ± 0.3	12.3 ± 0.1

TABLE 3.—DIMINUTION OF THE CARDIAC DIAMETERS DURING VALSALVA MANEUVER FOLLOWING EFFORT IN 17 WRESTLERS[a, b]

At Rest		After Exercise during Valsalva	
Transverse Diameter (cm.)	Longitudinal Diameter (cm.)	Transverse Diameter (cm.)	Longitudinal Diameter (cm.)
13.4 ± 0.2	14.5 ± 0.2	12.3 ± 0.2	13.6 ± 0.2

[a] Average diminution of the transverse diameter was about 8 percent and significant ($p<0.05$).
[b] Average diminution of the longitudinal diameter was about 6 percent and not significant.

Discussion

The average wrestler's pulse rate of 63 confirms the well-known bradycardia of athletes. The low normal arterial blood pressure in athletes is also characteristic, but the blood pressure values in control persons are almost identical. This may be attributed to the fact that in subtropical countries arterial blood pressure is generally lower than that of people living in Europe and North America.

Regarding the cardiac enlargement and the degree of hypertrophy and dilatation there is no agreement among investigators about this subject. It may be in part due to the fact that there is no uniform standard for normal heart size (22). Reindell (33) claims that there is enlargement in which dilatation plays the more important role and hypertrophy only small part. He based this on teleroentgenography records taken before and after effort during a Valsalva maneuver. We used Reindell's method in the study of wrestling, which exposes the contestants often to the conditions involved in the Valsalva maneuver, but as effort we used much heavier work than that used by Reindell. According to Koepplin (25), the elimination of the nervous factor could be obtained by utilizing a heavy work load. Because height and weight have more bearing on the transverse diameter than sex and age (25, 36), we used the Ungerleider-Gubner nomogram (38), which is based on the above mentioned factors, as standard values and compared our results in wrestlers with this nomogram and also with the heart diameters of our controls (Table 2).

According to Sunderman (36), transverse cardiac diameter in the adult male is an average of 12.2 cm. (range 9.3 cm. to 14.5 cm.) and, according to Friedberg (16), in the erect position is between 10 to 13 cm. Frey and others (15) have performed teleroentgenologic investigations on cyclists in the 30- to 40-year-old age group and found the mean transverse cardiac diameter to be 13.2 cm. Ungerleider and Clark's (37) findings in 1460 subjects, comprising a fairly representative sample of the population including all builds, ages, and occupations, revealed the average transverse diameter to be approximately 13.28 cm. In our subjects, the transverse cardiac diameter averaged about 13.4 cm.

Compared with the Ungerleider-Gubner nomogram and with the above mentioned values, the cardiac diameter of wrestlers is within normal limits. When it is compared with the cardiac diameter of our control subjects, it appears significantly enlarged ($p<0.001$). The transverse diameter of our control subjects, however, was slightly less than that of the nomogram (Table 2).

Concerning the degree of dilatation, a slight diminution has been found in wrestlers' transverse and longitudinal diameters during the Valsalva maneuver, which is 8 percent of the transverse and 6 percent of the longitudinal diameters (Table 3) and not acceptable as evidence for cavity dilatation. When one takes into consideration this data, it is concluded that wrestlers' cardiac transverse diameters are at the upper limits of normal values.

Summary of Findings

1. Bradycardia and low arterial blood pressure were found in wrestlers.
2. The transverse cardiac diameter of wrestlers was the same as the values found in normal people by others.
3. The transverse diameter of wrestlers' hearts was larger than that of controls.
4. The average transverse diameter of control subjects was slightly smaller than what was predicted and that which has been reported.
5. The diminution of wrestlers' cardiac diameters during the Valsalva maneuver following effort was nearly the same as the values found in controls.
6. Wrestlers' cardiac transverse diameters are considered at the upper limits of normal values.

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(Submitted 2/12/60)

Effects of Amphetamine (Dexedrine) and Caffeine on Subjects Exposed to Heat and Exercise Stress[1]

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Abstract

The purpose of this investigation was to determine if amphetamine (dexedrine) or caffeine affects the performance of a subject exposed to heat and exercise stress. Stress was provided by an ambient temperature of 110 deg. F and treadmill walking at four miles per hour, zero grade. Fifteen subjects each reported for three-hour experiments. Psychomotor and physiological measurements were taken each day under conditions held constant except for double-blind administration of drugs. Results indicate that, except for an increase in heart rate, neither amphetamine (dexedrine) nor caffeine produced facilitating or deleterious effects on any of the psychomotor or physiological measurements in this investigation.

THIS STUDY WAS undertaken to determine if amphetamine (dexedrine) or caffeine affects the performance of subjects exposed to a three-hour period of heat and exercise stress. Attention has recently been focused on the use of stimulating drugs to increase athletic performance. This reported practice generated considerable concern among the American Medical Association's Committee on Amphetamines and Athletics. Consequently, the Committee sanctioned two simultaneous research studies which have recently been reported in the literature. One study on the use of amphetamines and athletic performance was conducted by Smith and Beecher (5) at Harvard. This study demonstrated that 14 to 21 mg. of amphetamine per 70 kg. of body weight ingested two to three hours before athletic participation resulted in an appreciable improvement in performance (75% of the athletes tested improved their performance). Running, swimming, and weight-throwing performances of the athletes were measured. The findings of the second experimental study, which was conducted by Karpovich (3) at Springfield College under somewhat different experimental conditions, differed from those of the Harvard study. The study by Karpovich showed that 50 subjects out of 54 tested showed neither beneficial nor deleterious effects from the ingestion of 10 to 20 mg. of amphetamine given either one-half or one hour before the tests. Of the four subjects whose performances changed, three demonstrated improvement and the fourth subject showed a decrement.

[1] This investigation was supported by the Research and Development Division; Office of Surgeon General; Department of the Army, under Contract No. DA-49-007-MD-949.

While the Harvard and Springfield laboratories were conducting their experimental research, two questionnaire surveys were being conducted to determine how widespread the usage of amphetamines was among athletes. The Committee on Amphetamines and Athletics of the AMA was responsible for one of the surveys and the other was under the auspices of the American College of Sports Medicine. The questionnaire survey by the AMA Committee did not substantiate the belief that amphetamine enjoys the widespread use by athletes that had been reported; it further stated that only 1 percent of the persons polled (coaches, team doctors, and trainers) had ever administered amphetamine to their athletes. The survey conducted by the American College of Sports Medicine (1) showed that 46 of 133 (35%) respondents (professional and amateur coaches, trainers, and physicians) indicated that they had knowledge and/or experience regarding the use of drugs by athletes.

This study was undertaken in view of the lack of definitive and clear investigations regarding the effects of stimulating drugs on physical performance.

Procedures

Subjects were 15 graduate students in physical education at the University of North Carolina. Immediately prior to their participation in the experiment, they were given a special and complete physical examination by a University physician who participated in the total experiment as a consultant. The subjects had an average age of 25 years (with a range of 21 to 29 years), an average height of 5 ft. 11 in. (ranging from 5 ft. 7 in. to 6 ft. 4 in.), and an average weight of 171 lbs. 5 oz. (ranging from 149 lbs. to 210 lbs.). The subjects were exposed during three three-hour periods to exercise stress in a heat chamber with an ambient temperature of 110 deg. F. Exercise stress was provided by a motor-driven treadmill, moving at four miles per hour at zero grade. During the three-hour experimental periods the subjects followed the procedure of alternate 30-min. periods of walking on the treadmill and resting in a seated position. Subjects were trained in treadmill walking and given the battery of psychomotor tests (to remove learning effects) during three acclimatization periods.

Administration of Drugs

A double-blind technique was used in the administration of the drugs. The dosage was recommended by consultants from the University of North Carolina Medical School and the Department of Pharmacology, and was as follows:

Amphetamine (dexedrine). The subject ingested a capsule containing 5 mg. of amphetamine (dexedrine), plus some milk sugar and charcoal, 30 minutes before participating in the experiment. (Subjects had previously indicated to the university physician that they had never used the drug).

Placebo. The subject ingested a capsule containing milk sugar and charcoal 30 minutes prior to the beginning of the experiment.

Caffeine. The subject ingested a capsule containing 5 grains (324 mg.) of caffeine citrated, plus some milk sugar and charcoal, 30 minutes prior to the beginning of the experiment.

Caffeine was used in this study to prevent the subject from identifying the amphetamine (dexedrine) capsule. Both of these drugs are cerebral stimulants with the same general effects on the sensory cerebral cortex. It has been reported by one investigator (4), who used Olympic athletes as subjects, that caffeine enhanced muscular performance in the high jump where mental precision was involved. The same investigator reported that where speed was involved, as in the 100-meter dash, runners, receiving caffeine did not improve their performance.

The use of caffeine to mask the effects of amphetamine (dexedrine) in this study permitted the investigation of the effects of both drugs on physical and mental performance.

Psychomotor and Physiological Measurements

Heat gain. Heat gain was measured by a telethermometer. Temperatures were measured in six areas as recommended by Hardy and DuBois (2). Thermistor skin electrodes with wheatstone bridge and galvanometer circuit were applied to forehead, arm, chest, back, and thigh, and a thermistor rectal electrode was inserted to record rectal temperature. Gain was computed from the beginning to the end of the three-hour experiment.

Sweat loss. Total body weight loss during the experiment was taken as sweat loss.

Heart rate. Heart rate was measured for 30-sec. periods by stethoscope and by radial palpitation.

Mental performance (reliability = .72). Mental performance was determined by a test in which the subject added two-digit numbers. The 4 two-digit numbers had a three-digit sum written below. All problems, correct and incorrect, had the right hand number of the sum correct. The subject worked for three minutes, drawing a circle around the correct problems and marking an X through the incorrect ones. His score was determined by subtracting the incorrect from the correct.

Strength (reliability = .93 for handgrip, .77 for back lift, .86 for leg lift). Strength was measured by standard hand, back, and leg dynamometer tests. The subject was given three trials with each hand and one trial on the back and leg tests. Total strength was computed by adding the scores of both handgrips, the back lift, and the leg lift.

Reaction time to light stimulation (reliability = .77). The electrically connected equipment consisted of a chronoscope with one-hundredths of a second divisions, a small red light on the panel and a cut-off button on a block located on the subject's side, a reset button for the chronoscope on the examiner's side and, also on the examiner's side, an activating button for the

chronoscope and the light. The subject was seated and given ten trials. The median time, in hundredths of a second, was recorded.

Hand and arm steadiness (reliability = .88). The electrically connected equipment consisted of a stylus with a diameter of 1/16 in., a metal plate with a 1/4 in. aperture, and an electric counter. The subject was seated and held the stylus in his preferred hand with arm extended. Two 30-sec. trials were conducted and the mean number of contacts was recorded.

Two-hand coordination (reliability = .64). The electrically connected equipment consisted of two styli, an electric counter, and two circular patterns of metal plates with diameters of 5¼ in. The plates were divided into four numbered sections. The left plate was numbered 1 and 2 from left to right and 3 and 4 from top to bottom. The right plate was numbered 1 and 2 from top to bottom and 3 and 4 from left to right. The subject was seated and given a 30-sec. trial in which, with a stylus in his right hand, he tapped as rapidly as possible the pattern 1, 2, 3, and 4 on the right hand plate. The same procedure was followed with the left hand. The subject was then given a 30-sec. trial in which he used both hands and had to tap the correspondingly-numbered plates at the same time to record a score. The score on this test was a ratio derived by dividing the score with both hands by the sum of the scores with each hand.

Speed of tapping (reliability = .74). Equipment for this test was the same as that used to test one hand in the two-hand coordination test. The subject was seated and tapped one section of the plate as rapidly as possible. (Two 30-second trials were conducted and the mean number of taps was recorded.)

Rate of manipulation. The United States Employment Service Rate of Manipulation Test (peg board) was used to measure rate of transfer (reliability = .79) and inversion (reliability = .77) of pegs. One trial was conducted on each test and the time on each test was recorded in seconds and tenths.

Experiment Protocol

1. Procedure before subject entered hot room.

   Subject undressed and weighed.
   Steadiness and two-hand coordination tests administered.
   Seated heart rate taken.
   Tapping, reaction time, and peg board tests administered.
   Mental test administered.
   Hand, back, and leg dynamometer tests administered.
   Skin electrodes attached and rectal electrode inserted.
   Seated heart rate and six temperature readings recorded.

2. Procedure after subject entered hot room.

   Walk 1-30 minutes.
   At 10 minutes—heart rate and six temperature readings recorded.
   At 20 minutes—heart rate and six temperature readings recorded.
   At 30 minutes—heart rate and six temperature readings recorded.

Rest 31-60 minutes.

At 35 minutes—Steadiness and two-hand coordination tests administered.
At 40 minutes—heart rate and six temperature readings recorded.
At 41 minutes—tapping, reaction time, and peg board tests administered.
At 50 minutes—heart rate and six temperature readings recorded.
At 60 minutes—heart rate and six temperature readings recorded.

Walk 61-90 minutes.

At 70 minutes—heart rate and six temperature readings recorded.
At 80 minutes—heart rate and six temperature readings recorded.
At 90 minutes—heart rate and six temperature readings recorded.

Rest 91-120 minutes.

At 95 minutes—mental test administered.
At 100 minutes—heart rate and six temperature readings recorded.
At 101 minutes—hand, back, and leg dynamometer tests administered.
At 110 minutes—heart rate and six temperature readings recorded.
At 120 minutes—heart rate and six temperature readings recorded.

Walk 121-150 minutes.

At 130 minutes—heart rate and six temperature readings recorded.
At 140 minutes—heart rate and six temperature readings recorded.
At 150 minutes—heart rate and six temperature readings recorded.

Rest 151-180 minutes.

At 155 minutes—steadiness and two-hand coordination tests administered.
At 160 minutes—heart rate and six temperature readings recorded.
At 161 minutes—tapping, reaction time, and peg board tests administered.
At 170 minutes—heart rate and six temperature readings recorded.
At 180 minutes—heart rate and six temperature readings recorded.

3. Procedure after subject came out of hot room.

Skin and rectal electrodes removed.
Steadiness and two-hand coordination tests administered.
Seated heart rate taken.
Tapping, reaction time, and peg board tests administered.
Mental test administered.
Hand, back, and leg dynamometer tests administered.
Subject undressed and weighed.

Analysis of the Data

The statistical procedure employed as a control involved measuring for each subject the difference in performance before beginning the experiment and the performance at each ensuing test or trial period. The difference obtained gave an indication of the increment or decrement in performance brought about by a particular drug after a certain length of exposure to heat and exercise stress. When the intertrial change for a particular drug treatment was compared to the intertrial change for the placebo treatment, the difference indicated the degree of increment or decrement in performance of that subject brought about by the influence of the treatment. Each drug treatment was compared in this manner to the placebo treatment for all 15 subjects. For each such comparison made, the differences of the intertrial changes for the 15 subjects were added as were the squares of these differences, and t values computed. Table 1 shows the t values derived from an analysis of the data.

TABLE 1.—T VALUES DERIVED FROM COMPARING INTERTRIAL CHANGES OF AMPHETAMINE (DEXEDRINE) AND CAFFEINE WITH INTERTRIAL CHANGES OF PLACEBO

Conditions compared	Trials	Steadiness	Coordination	Tapping	Reaction time	Rate of transfer	Rate of inversion	Mental	Strength	Heat gain	Sweat loss	Heart rate
Dexedrine-Placebo	(1-2)	—0.513[a]	1.441	0.516	0.402	0.553	—1.175	—1.092	—0.486	1.525	—0.678	3.030[b]
Dexedrine-Placebo	(1-3)	—1.416	1.437	0.292	—0.131	0.840	—0.809	—0.644	—0.879			2.067
Dexedrine-Placebo	(1-4)	—0.773	—0.184	0.215	—0.069	0.933	—0.967					1.593
Dexedrine-Placebo	(1-5)											2.408[c]
Dexedrine-Placebo	(1-6)											1.467
Dexedrine-Placebo	(1-7)											1.244
Caffeine-Placebo	(1-2)	—0.135	0.385	—0.389	—0.441	0.813	—1.255	—0.454	0.840	1.063	0.546	3.205[b]
Caffeine-Placebo	(1-3)	—0.829	1.315	0.154	—0.385	—0.747	—0.655	—0.264	0.899			2.641[c]
Caffeine-Placebo	(1-4)	1.547	0.189	—0.500	—0.744	0.090	—0.539					0.976
Caffeine-Placebo	(1-5)											1.759
Caffeine-Placebo	(1-6)											2.049
Caffeine-Placebo	(1-7)											0.557

[a] Negative sign indicates drug caused more improvement or less impairment for time interval measured than did placebo.
[b] Indicates 5 percent level of confidence = 2.145.
[c] Indicates 1 percent level of confidence = 2.977.

Conclusions

Five grains (324 mg.) of caffeine, and 5 mg. of amphetamine (dexedrine) produced an increase in heart rate during the first half hour of the experiment which, when compared to placebo, was significant at the 1 percent level of confidence.

It was also noted that when amphetamine (dexedrine) treatment was compared with placebo treatment at the end of two hours of the experiment, the heart rate increase was significant at the 5 percent level of confidence.

Caffeine treatment produced an increase in heart rate for the first 60 minutes of the experiment. When this heart rate increase was compared with the placebo treatment for the same test period, it was significant at the 5 percent level of confidence.

None of the subjects while under the influence of either amphetamine (dexedrine) or caffeine demonstrated statistically significant effects on any of the psychomotor or physiological measurements in this study, other than the heart rate increases mentioned above.

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Effect of Mental Practice on the Development of a Certain Motor Skill

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Abstract

The effect of mental practice was compared with that of physical practice in the development of a motor skill, the Pacific Coast one-hand foul shot. One hundred and forty-four high school boys were equated into physical and mental practice groups on the basis of arm strength, intelligence, and varsity, junior varsity, or novice experience. Mental practice was found to be nearly as effective as physical practice under the conditions of the experiment.

PHYSICAL EDUCATORS and coaches are becoming increasingly aware of the potential importance of the mental aspects of motor learning. To date, this awareness seems to be based more on intuition than on research evidence. For example, an extensive examination of literature disclosed only a few pieces of research that were designed primarily to investigate the effect of mental practice on the learning of motor skill. Wilbur E. Twining (11) made an observation in 1949 that is still true.

In spite of the rapid advancement in the scientific approach to physical education, there is little in the literature to indicate just how much motor learning is physical and how much mental. There is little doubt that knowledge of mental activity required for efficient motor learning would aid physical educators in an understanding of teaching techniques. But the variable of mental activity is one which is difficult to isolate and measure. At best it can be roughly compared to its given counterpart in physical activity. The very sparseness of references to this concept in the literature serves all the more to emphasize the importance of this gap in our knowledge.

In addition to the study by Twining, studies by the following are pertinent to the investigation: Vandell, Davis, and Clugston (12), Trussell (10), Perry (6), Harby (3), Flanagan (2), G. Rubin-Rabson (8), and Shaw (9). Although limited in number and scope, these studies provide sufficient evidence that "mental practice," or mind rehearsal of motor skill may produce enough improvement to warrant further and more intensive investigation of its potential effect.

This study attempted to determine if mental practice, when substituted for physical practice in the development of a certain motor skill, will result in improvement of that skill. The skill used was the Pacific Coast one-hand foul shot.

Procedures

It is folly to attempt to evaluate accurately in one experiment all the variables affecting any motor skill. Accordingly, the present research was centered around the careful investigation of one major question, the effect of substituting mental practice for physical practice in the development of a certain motor skill. The supplemental considerations of the influence of arm strength, intelligence, and experience were included. Although it is not possible to equate for all variables, it is possible to set up an experimental design

so that a number of causes of variation not controlled by the experiment can be later evaluated from the data by Fisher's covariance analysis technique. This was done using Johnson's development of that technique (5).

Two high schools in Detroit and two from the suburbs were selected for participation in the experiment. A fifth school was held in reserve, in case something occurred necessitating a repetition of the experiment. Three categories of experience, varsity, junior varsity, and novice, composed of 12 subjects each, were used. There were thus 36 subjects from each of four high schools, making a total of 144 subjects, which assured a statistically adequate sample.

A 144-cell factorial grid was prepared for the application of the covariance analysis technique. The grid was arranged to take into consideration the following: schools, classes or categories of experience (varsity, junior varsity, novice), measures (initial and final score), arm strength (high, average, low), intelligence (high, low), and groups (mental practice and physical practice). The subjects were equated for arm strength and intelligence by a paired-groups technique. Chance drawing was used to assign the equated subjects to the mental and physical practice groups.

Arm strength was measured by the Frederick Rand Rogers' formula as found in his strength index (7). Intelligence was measured by the short form of the California Mental Maturity Test. It is recognized that the best measure of intelligence cannot be obtained through group testing. However, considerations of cost and time prohibited the use of individual tests such as the Stanford-Binet. It is also recognized that research has disclosed little correlation between group intelligence test scores and motor ability. It was considered a possibility, however, that this particular experiment, dealing more strongly with the mental aspects of motor learning, might cause the intelligence quotient to appear in a new light in its relation to motor skill.

Monday was selected for the start of the experiment. At this time all the 36 subjects at one school were instructed to read a group introduction to the experiment. They then read printed information on the technique for shooting the Pacific Coast one-hand foul shot. The next step was for subjects to position themselves on a line facing the instructor, who gave them instructions in the shooting technique to be employed during the experiment. The subjects were asked to pose through the sequence of positions of body and limb, without a basketball, as the instructor described and demonstrated them. *Knowing*, specificity of motions; *seeing*, self and instructor while posing through the successive positions; and *feeling*, kinesthetic sensations with eyes both opened and closed, were emphasized. These instructions were then repeated, with each subject handling a basketball. Each subject then shot 25 consecutive practice shots and the instructor corrected any mistakes in technique. After the instructions were again repeated, the subjects were instructed to shoot 25 foul shots, striving to make the best score possible. They were informed that this would be the initial score for the experiment and that a final score would be obtained at the termination of the experiment for

the purpose of measuring improvement. The number of shots made out of 25 attempts was recorded on physical-practice-group and mental-practice-group record sheets, in the order determined by the paired-groups technique of equating the subjects for the factorial grid.

Each subject was notified at this time of the group to which he had been assigned. Great care was taken to avoid mentioning anything that would let those subjects who would make up the physical practice group know that there would be a mental practice group. To assure this objective, the mental practice group was referred to only as the experimental group. The subjects of this special group were told of their part in the experiment in private and requested not to discuss it with anyone. The subjects in the physical practice group were likewise privately advised of their role in the experiment.

The physical practice group was asked to consider itself as competing against the experimental group using a shooting technique in which much greater emphasis than normally employed was to be placed on sharpening the basic perceptual abilities. They were reminded of the fact that many games are won and lost at the foul line. The thought was presented that each player might well improve his shooting skill by serious participation in the experiment.

The physical practice group was instructed to shoot 5 warm-ups and 25 shots for test score for each of the 14 school days of the experiment. The final test day was scheduled for the fourth Monday with 25 warm-ups and 25 shots for test score being taken. No instructions were given during the course of the experiment after the first day.

On Tuesday, the second day of the experiment, the experimental group was assembled in private. Subjects were given a written introduction to the mental practice technique. A few words of caution were given as to the importance of keeping the procedure secret. They were told to consider themselves as competing against the physical practice group by using a new learning technique. A brief description of the motor theory of consciousness, as discussed by Jacobson (4), was given to support a simple demonstration indicated in the written introduction to the mental practice technique.

The subjects were then instructed to read carefully through the mental practice work sheets. It was explained that they were to read these sheets once each day at the beginning of the mental practice session even though it was expected that the contents would be memorized in a few readings. The thought behind this procedure was that it would channel the subject's thinking and thus prevent his mind from wandering, a phenomenon that had reportedly occurred in previous mental practice experiments.

The mental practice group was instructed to engage in mental practice (imagine shooting 5 warm-ups and 25 for score) for the remaining 14 school days, with the final test day to fall on the fourth Monday. The final score was obtained by the same method used for the physical practice group—25 warm-ups and 25 shots for score. No instructions were given to this group at any time after the first Tuesday of the experiment.

This experimental procedure was repeated in the three other high schools. It had been planned for the coach at each successive school to handle the instruction period, but due to the pressure of the work schedules of the coaches it became necessary for the author to do so in three out of the four schools. This reduced the effect of one other possible variable, the personality and instructional skill of the coaches.

In previous experiments with mental practice, a control group had been set up in which the subjects participated on only the first and last days of the experiment. They were required to do no practice of any kind, either mental or physical, on the days in between. The improvement under these conditions was negligible, ranging from −2 percent to +4 percent when only a few subjects were involved. This is in line with fluctuations in scoring one can expect on a day-to-day basis. Pilot studies by the author disclosed that with larger numbers of subjects participating in such control groups there was generally a loss when subjects engaged in no practice of any kind for a period of three weeks. For this reason, such a control group was not set up in the present experiment.

Introspective Analysis

Introspection is defined as the examination of one's mental states or processes. Introspective analysis is a psychological technique, generally employed in research to examine a subject's reactions (mental) to an experimental process.

A major criticism against the method of introspective analysis is that since there is no overt behavior which may be observed and examined by the customary methods of obtaining and treating data, it cannot be reliable. It was used at the end of the experiment, however, with the thought that introspective analysis engaged in according to the natural ability and experience of the subjects might produce observations and insights that could well give important clues to further constructive research.

Treatment of Data

As indicated in Table 1, 31 sources of interaction variation were submitted to statistical treatment by the analysis of covariance technique. The amounts of improvement of the mental and physical practice groups for the three classes of experience in each school were subjected to the t-test of significant difference between the means. The comments by the subjects during introspective analysis were tabulated, categorized, and filed.

Simple mathematical computations of the percentage gains for the several disparate groups were made. This was not a case of placing more credence in statistically untested percentages than in a statistical test of significance. Recognizing the danger of being misunderstood, the author, nevertheless, felt that such a procedure might possibly provide some insight into the effect of the factor of playing experience on mental practice. This proved to be the case.

TABLE 1.—TEST OF SIGNIFICANCE OF INTERACTIONS

Source of Variation	D.F.	ΣY^2	ΣX^2	ΣXY	D.F.	Reduced ΣY^2	Mean Square	F-Ratio	Null Hypothesis
1. Arm Strength × Intelligence × School × Class × Group	12	51	122	45	11	34.41	3.128	.....	
2. Arm Strength × Intelligence × School × Class	12	104	131	99	12	38.63	3.129	1.03	
3. Arm Strength × Intelligence × School × Group[a]	6	10	68	—1	6	16.40	2.733	.....	
4. Arm Strength × Intelligence × Class × Group	4	20	20	19	4	7.75	1.938	.....	
5. Arm Strength × School × Class × Group	12	66	147	37	12	57.60	4.800	1.53	
6. Intelligence × School × Class × Group	6	25	75	26	6	16.00	2.667	.....	
7. Arm Strength × Intelligence × School	6	45	68	17	4	41.38	6.897	2.20	
8. Arm Strength × Intelligence × Class	4	62	9	—18	2	73.03	18.258	5.84	Rejected (.01)
9. Arm Strength × Intelligence × Group	2	4	33	9	12	1.78	.890	.....	
10. Arm Strength × School × Class	12	55	137	35	6	100.88	8.407	2.69	In Doubt
11. Arm Strength × School × Group	6	84	65	—16	4	96.10	16.017	5.13	Rejected (.01)
12. Arm Strength × Class × Group	4	77	44	40	6	50.07	12.518	4.00	Rejected (.05)
13. Intelligence × School × Class	6	53	143	21	3	53.29	8.881	2.84	In Doubt
14. Intelligence × School × Group	3	9	14	4	2	7.94	2.647	.....	
15. Intelligence × Class × Group	2	19	14	15	6	9.12	4.560	1.46	

TABLE 1. (*Continued*)

Source of Variation	D.F.	ΣY^2	ΣX^2	ΣXY	D.F.	Reduced ΣY^2	Mean Square	F-Ratio	Null Hypothesis
16. School × Class × Group	6	88	152	24	2	87.22	14.537	4.65	Rejected (.05)
17. Arm Strength × Intelligence	2	41	31	34	6	16.80	8.400	2.69	
18. Arm Strength × School	6	25	46	20	6	16.44	2.740	----	
19. Arm Strength × Class	4	74	146	55	4	53.28	13.320	4.26	Rejected (.05)
20. Arm Strength × Group	2	10	34	19	2	.33	.165	----	
21. Intelligence × School	3	34	4	3	3	32.31	10.770	3.44	In Doubt
22. Intelligence × Class	2	12	49	13	2	8.92	4.460	1.43	
23. Intelligence × Group	1	6	17	—10	1	13.78	13.780	4.41	In Doubt
24. School × Class	6	135	82	72	6	84.49	14.081	4.50	Rejected (.05)
25. School × Group	3	37	114	37	3	25.10	8.367	2.67	
26. Class × Group	2	2	19	6	2	.14	.070	----	
27. Arm Strength[b]	2	31	77	—6	2	39.95	19.975	6.39	Rejected (.05)
28. Intelligence[b]	1	3	6	—4	1	6.46	6.460	2.06	
29. School[b]	3	241	63	76	3	178.45	59.483	19.02	Rejected (.01)
30. Class[b]	2	631	853	734	2	585.35	292.675	93.57	Rejected (.01)
31. Group[b]	1	34	4	2	1	33.06	33.060	10.57	Rejected (.01)
Total	143	2088	2787	1407	142	178.46			

[a] The null hypothesis that is being tested concerns the variation in the same row. For example, the hypothesis regarding arm strength × intelligence × school × group (number 8 above) is that there is no significant interaction between arm strength, intelligence, school, and group when the effect of the initial foul shooting score has been partialed out.

[b] The null hypothesis that is being tested concerning the variation in the same row where only one factor appears (numbers 27, 28, 29, 30, and 31[b] arm strength, intelligence, school, class, group, respectively), is that there is no significant difference between the factor's means when the effect of initial score has been partialed out.

Both the physical practice and the mental practice groups showed highly significant gains with t-test values of 10.5 and 7.7 respectively. The general improvement of both groups indicates great potential for the instructional techniques employed in this experiment, especially when used in physical education classes.

As a result of the analysis it was found that the variables of arm strength, school, class (experience), and group (mental and physical practice) were statistically significant. The three factors of school, class, and group were significant at the 1 percent level, while the variable of arm strength was significant at the 5 percent level. The factor of intelligence exerted no statistically significant influence.

Physical practice resulted in average gains of 16 percent for the varsity groups, 24 percent for the junior varsity groups, and 44 percent for the novice groups; mental practice resulted in average gains of 15 percent, 23 percent, and 26 percent for the equivalent categories. Comparison shows that mental practice was almost as effective as physical practice for the varsity and junior varsity groups, and not as effective for the novice groups. These results are quite similar to those of Vandell, Davis, and Clugston (12), who concluded that mental practice was about as effective as physical practice under the conditions of the experiment.

One may argue that such percentage comparisons are unfair because the degree of proficiency in shooting for the varsity is such that there is less chance for improvement than in the case of the junior varsity and novice groups. This is true; however, the author was attempting to discover if experience affected the degree of improvement of a motor skill through mental practice. It was felt that a perspective based on such comparisons might give a clue. The high degree of improvement from mental practice experienced by the varsity groups suggests that perhaps a certain amount of motor experience is necessary before mental practice will provide a maximal effect. Further research is indicated.

Some unexpectedly adverse experimental conditions developed at the first school participating in the experiment. Since the experiment was run at the end of the school year, preparation for final examinations, graduation, and other activities such as a crowded schedule of baseball games and track meets caused the varsity and junior varsity subjects to be pressed for time. They were all obviously tired. There was an additional complicating factor not discovered until several months later. The coach, on his own admission, had made facetious and deprecating remarks to the varsity and junior varsity subjects concerning the possibilities of mental practice. The subjects, after this disclosure, admitted that the coach's remarks had definitely lessened their enthusiasm for carrying out the experimental procedure as directed by the author. By contrast, the novice mental practice subjects, who were not exposed to the coach's remarks, experienced the most improvement of any of the novice mental practice groups involved in the experiment.

It is interesting to note that, when the average gain of the varsity and junior varsity mental practice groups of schools II, III, and IV is computed to the exclusion of school I, the average percentage of improvement for the varsity mental practice groups changes from 15 percent to 28 percent, and the junior varsity mental practice groups from 23 percent to 38 percent. These figures, considered with the fact that the results in schools II, III, and IV show considerable uniformity as contrasted with school I, suggest the strong possibility that mental practice has a greater potential than the percent of improvement for the four schools combined indicate.

Results of Introspective Analysis

The 72 mental practice subjects were asked to introspectively evaluate the introductory training period, the purpose of which was to train them in better use of basic perceptual abilities for the development of motor skills. The reports were all favorable. All but two subjects reported that their initial scores were better than what they formerly had been accustomed to shooting. The introspective analyses indicated that the subjects apparently represented a wide range of ability to visualize, or imagine, the shooting movements of the basketball skill involved.

They also disclosed that several of the subjects experienced hallucinations of the shooting technique. For example, one subject reported mentally attempting to bounce the ball preparatory to shooting only to imagine that it would not bounce and stuck to the floor. This disturbed him to a point where he could not successfully visualize the shooting technique. He stated that if he visualized shooting without first bouncing the ball, he avoided the difficulty and could mentally practice the technique with a fair degree of facility. The presence of a strong emotional factor is suggested as a possibility for this hallucination.

Another subject also had difficulty as a result of imagining bouncing the ball preliminary to shooting it. He reported imagining bouncing the ball and catching it in rapid succession. Then he had great difficulty stopping the hallucination of bouncing the ball so he could visualize completing the shot.

One subject reported visualizing the ball going into the basket without a net. The ball would disappear then come plummeting back "out of nowhere" and hit him in the abdomen. This hallucination kept recurring for two weeks of the experiment. He never did get to visualize the net on the basket. His coach reported that during the previous basketball season, this subject, although a good floor shot, would experience unexpected lapses in shooting skill during a game when he would miss simple shots by a wide margin. Strong emotional factors, possibly psychological trauma, and perhaps poor perceptual ability, are suggested as possible causes of this hallucination.

Another subject also had difficulty visualizing the shooting technique. He reported that instead of imagining arching the ball in a normal trajectory his imaginary shots would go way out to the left then swerve back into the basket. He also had the impulse to shoot as soon as he had the imaginary

ball in his hands. This impulse continued throughout the experiment and was observable when he took the final test shots. He took no time to get set, aim, and shoot as the average person does.

All of the mental practice subjects introspectively reported a growth of the ability to visualize, or imagine, the shooting technique to some degree. All but six subjects introspectively reported that they experienced a progressive increase in confidence that they would be able to shoot better. All but the same six also reported the development of a more acute sense of instantly recognizing mistakes in shooting technique by the time of the actual testing for final score. All 72 physical practice subjects reported that they felt they had improved in this sense.

The introspective analyses suggested a strong relationship between the subject's ability to visualize the motor skill and the amount of improvement experienced. A need is indicated for further research in which basic perceptual ability is carefully measured so that a more accurate determination of this relationship can be made. It appears that mental practice has great potential for sharpening perceptual ability.

Summary and Conclusion

1. Both the physical and mental practice groups showed highly significant gains with t-test scores of 10.5 and 7.7, respectively.

2. Physical practice resulted in average gains or 16 percent for the varsity groups, 24 percent for the junior varsity groups, and 44 percent for the novice groups, while mental practice resulted in average gains of 15 percent, 23 percent, and 26 percent for the equivalent categories. Thus mental practice was almost as effective as physical practice for the varsity and junior varsity groups, and not as effective for the novice groups.

3. Covariance analysis disclosed that there was a significant difference between the means of the adjusted final scores of arm strength, school, class, and group categories. The latter three were significant at the 1 percent level, while the factor of arm strength was significant at the 5 percent level. There was no significant difference between the means of the adjusted final scores of intelligence, as measured by the short form of the California Mental Maturity Test.

4. All of the mental practice subjects introspectively reported a growth of the ability to visualize and imagine the shooting technique to some degree. The introductory training period was credited for making this possible.

There may well be some optimum combination of mental and physical practice periods that is superior to methods generally employed today to develop motor skill.

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Correlation between the Strength/Mass Ratio and the Speed of an Arm Movement[1]

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Abstract

The speed of a lateral arm movement and the strength/mass ratio were measured in 48 university male students. The correlation between the movement time and S/M was not significant ($r = -.277$) and verified results of similar studies from this laboratory. The reliability of individual differences for all variables was high. These findings support the concept that the ability to exert muscular strength in a coordinated manner is determined by a specific neuromuscular coordination pattern. There was no significant correlation found between reaction time and speed of movement.

AN ASSERTION sometimes made in physical education is that there is a considerable relationship between an individual's static strength and his ability to move at high speeds (3, 4). Although this viewpoint has persisted for some time, recent data have challenged this assumption; indeed, there is evidence of a lack of correlation between these variables.

In 1954, Rasch (6) studied the speed of movement of an arm in relation to the strength of that arm. His findings showed no significant correlation between them. Hypothesizing that the muscular force utilized in a movement performed at maximum speed is limited physiologically and is determined by a neuromotor coordination, Henry and Whitley (2) more recently examined individual differences in arm mass, static arm strength, and strength in action. They also found no significant correlation, even though the reliability was high for all variables. These results substantiated their theory that strength in action is controlled by the neuromotor coordination centers of the nervous system and evidently exhibits the high specificity that is found in other activities of this nature.

In an effort to shed additional light on this problem with another sample of subjects and a somewhat different method of strength measurement, the present study investigates further the relationship of individual differences in arm speed, strength, and mass. Reaction times have also been examined, so that the data can be brought to bear on the controversial question of how much correlation exists between ability to react quickly and ability to move quickly (7).

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[1] From the Research Laboratory of the Department of Physical Education.

Methodology

Subjects. The subjects in this study were 48 male university students, volunteers enrolled in elementary physical education classes, but otherwise unselected. Their average arm strength scores were midway between the two samples of subjects tested by Henry and Whitley (2), although the variability was approximately 25 percent higher.

Measurement of Movement. The subject stood erect, with his right arm extended laterally at shoulder height. His hand rested on a double-action microswitch. During the movement he swung his arm leftward in a horizontal plane at maximal speed for a distance of 117 cm. to strike a string and then follow through with maximal force. (This constant distance yielded an angular movement of approximately 110 deg., varying slightly according to the length of each subject's arm.) In order to time this action, two S-1 electric chronoscopes (1) were employed. The movement was started in response to an auditory signal. The first chronoscope started automatically at the sound of the starting stimulus and stopped when the subject moved his hand from the resting microswitch, thus giving a measure of reaction time (RT) and at the same time causing the second chronoscope to go into action. When the subject's hand touched the string it pulled out a switch which stopped the second chronoscope. The elapsed time on this second instrument gave a measure of the movement time (MT), which is the reciprocal of speed.

Measurement of Strength. The position of the subject for the measurement of arm strength was supine on a table, with the arm being tested extended laterally at shoulder height. On command, he applied a maximum upward pull against a 90-cm. wooden arm support, at the end of which was attached a spring balance, which in turn was securely anchored to the floor at right angles to the direction of pull. This wooden support was hinged at a point just above the pivot of the shoulder at the glenohumeral joint. The hinge was supported by an adjustable bridge attached to the table (see Figure 1). To ensure adequate stability for the subject during this test, the opposite shoulder was held in place by a two-inch web strap, which was passed through slots in the table and secured beneath it. The subject was told that the arm being tested was to remain extended and held rigid and that pressure was to be exerted in a smooth and even manner. The spring balance had a maximum scale reading of 16.3 kilograms (read to 0.1 kg.) and included a friction-sliding maximum indicator.

The spring balance was attached to a fixed position on the board, 90 cm. from the hinge, and so the dynamometer reading had to be multiplied by the ratio of 90 cm. to the arm length (as measured at a reference point on the hand) in order to obtain the true force exerted. It was also necessary to add the effective weight of the wooden arm support and the effective weight of the arm, since the force was exerted upward against gravity.

Measurement of Arm Mass. The effective arm mass was determined in the manner described in detail by Henry and Whitley in which the subject assumed a supine position on a table. The right arm was placed on a plywood

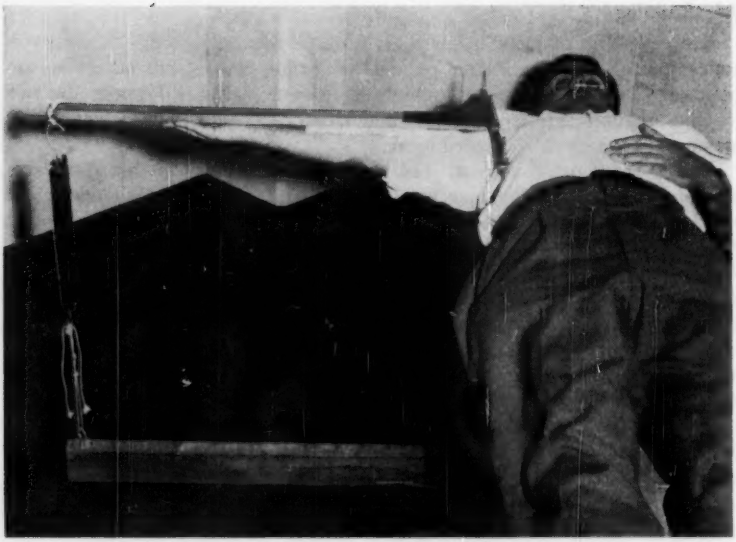

FIGURE I. Apparatus for Strength Measurement.

strip hinged directly under the pivotal point of the shoulder and weighed with a sensitive spring scale at the reference point on the hand (metacarpophalangeal joint). It was also possible in this way to determine the measurement of arm length. For each mass observation, the effective weight of the board was subtracted.

Experimental Procedures. Twelve measurements of reaction time and speed of movement were made employing the right arm of all subjects. A randomly varied time interval of from one to four seconds was used between the warning sound and the stimulus. After these measurements, three strength tests were given, rest periods between them being used for the six measurements of arm mass and the determination of arm length.

Computation of Strength/Mass Ratio. As pointed out earlier, the extended arm acts as a lever, supported and fixed at one end by a pivot, the shoulder joint. With a portion of its total mass borne at this point, it is obvious that the effective mass of the arm can be treated as though it were concentrated at the measurement point on the hand. It is therefore measurable as the relaxed weight of the free end of the arm. We are also interested in the effective force available at this reference point, as measured by the strength test. Mechanically, the speed of movement in this situation would be directly proportional to the force applied to the mass, and inversely proportional to the mass itself. The correlation of particular interest, therefore, is that found be-

tween individual differences in the strength/mass ratio (S/M) and the speed of movement.

Results and Discussion

Correlations for Speed and Strength. Results of the testing appear in Table 1. In computing the half-test reliability coefficients (underscored in the table), the following procedure was employed. For movement time, reaction time, and mass determinations the sums of the odd-numbered trials were correlated with the even-numbered trials. For the strength test, the first score was correlated with the second, and the second with the third. Inas-

TABLE 1.—DESCRIPTIVE STATISTICS AND CORRELATIONS FOR EXPERIMENTAL VARIABLES

Variables	M	σ	Reliability	Intercorrelations				
				S/M	Str.	Mass	M.T.	R.T.
S/M Ratio	15.576	5.164	——	——				
Strength (kg)	16.082	2.938	.956	.493	*.915*			
Mass (kg)	1.090	.222	.998	—.721	.110	*.995*		
Movement Time (sec)	.194	.022	.946	—.277	—.369	.121	*.898*	
Reaction Time (sec)	.226	.034	.893	.069	—.154	—.098	.045	*.807*

much as both of the strength reliabilities were nearly identical ($r = .910$ and .920, respectively), their average was used. All are high and comparable with others reported elsewhere (2) for these tests. The full-test reliabilities, computed by the Spearman-Brown method, are given in the third column of the table.

The correlation between movement time and S/M was not significant[2] ($r = -.277$); however, strength alone correlated with MT somewhat higher than this ($r = -.369$). Although this latter correlation was significant, when the two r's were compared statistically the difference between them was not significant since the t-ratio was only 0.67, using the statistical formula for differences when both correlations are obtained from the same sample of individuals (5).

The results verify those of Henry and Whitley in showing that there is no appreciable correlation between S/M and movement time. The writer can offer no logical reason for the finding of a significant correlation between raw strength and movement time, other than on the basis of sampling error which occasionally causes anomalous situations to occur. Even so, the correlation is quite low; the squared coefficient accounts for only about 14 percent of the common variance between strength and speed. In evaluating these results it should be remembered that the reliabilities for all measures were very high.

[2] For 46 deg. of freedom, correlations of .285 and .368 denote significance at the .05 and .01 levels, respectively.

Movement Time vs. Reaction time. The correlation found in this experiment ($r = .045$) agrees with the other studies from this laboratory, which have in general found a low and usually nonsignificant correlation between individual differences in movement time and reaction time.

Conclusions

The results of this study support the hypothesis that a high degree of specificity is exhibited in movements requiring the exertion of muscular force in a coordinated manner. Indeed, the lack of a general or high relationship between strength in action (as measured by its result, namely speed of movement) and the measured muscular strength, lends additional credence to the concept that each of these abilities is determined by a separate neuromuscular coordination pattern. Knowledge of the muscular strength cannot be used to predict successfully the speed of an arm movement.

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(Submitted 3/7/60)

Development of an Attitude Inventory to Measure the Attitude of High School Girls toward Physical Education as a Career for Women

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Abstract

An attitude inventory was developed for the purpose of determining the attitudes of high school girls toward physical education as a career for women. Likert's technique of scale construction was selected for use in this study. Statements covering aspects of the physical education profession as they apply to women were prepared according to recommended criteria. Each statement was subjected to statistical analysis in order to eliminate those which were ambiguous or which had poor discriminatory power. Following the use of the split-half method for determining reliability, the statements were divided into two equivalent forms of the inventory.

THE IMPORTANCE OF attitudes cannot be overlooked by those interested in encouraging high school girls to choose a career in physical education. Studies have indicated that attitudes are not rigid, unyielding elements of the personality, but that they can be changed through experience and knowledge. To ascertain whether or not recruitment programs have been successful in encouraging favorable attitudes toward the profession of physical education, it is helpful to have an objective means of measuring such attitudes. The purpose of this study, therefore, was to develop an attitude inventory to measure the attitude of high school girls toward physical education as a career for women.

An attitude is defined by Thurstone as a word used "to denote the sum total of a man's inclinations and feelings, prejudice or bias, preconceived notions, ideas, fears, threats, and convictions about any specific topic." Likert (3) modifies this definition slightly by adding that an attitude "is not an inflexible and rigid element in personality . . . but rather a certain range within which responses move." Any measurement of attitude contains certain limitations and restrictions. In order to obtain an honest evaluation of a girl's attitude, she must be encouraged to respond to the inventory items carefully and truthfully. The fact that there may be discrepancies between opinions as checked on the attitude inventory and actual attitude must be recognized. Therefore, it must be kept in mind that the score obtained on any such inventory is indicative of attitude, but not necessarily an infallible guide to actual conduct. For that matter, actions themselves may be distorted, and

often are, to gain social approval, when in reality they are not truly expressive of a person's attitude.

Procedure

Literature in the field of attitude measurement suggested two methods, those of Thurstone (4) and Likert (3), as being the most widely used means of constructing an objective attitude scale. Likert's method of summated-ratings was selected for the construction of the attitude inventory in this study. In this technique of attitude measurement a number of statements concerning the subject of the attitude inventory are prepared and then presented to a group of respondents who are asked to check one of five possible expressions of opinion regarding each statement. In this study the choice was as follows : (1) I strongly agree; (2) I agree; (3) I am undecided; (4) I disagree; (5) I strongly disagree. Each choice had an assigned value ranging from five points for the answer most strongly in favor of physical education as a career for women to one point for the least favorable choice. An individual's attitude score was considered to be the sum total of these point values.

The statements prepared for use on this scale were related to the profession of physical education in terms of the program objectives, the personal characteristics of women in the profession, the opinions of others regarding the profession, and the academic requirements of college curriculums leading to a degree in physical education. There were 88 statements concerning these areas formulated according to the criteria proposed by Wang (5). Half of the statements were phrased negatively and mixed indiscriminately with positive statements to guard against an automatic checking response.

The original list of 88 statements was presented to a group of 208 high school girls representing two city schools and one county school in the Indianapolis area. Typed directions accompanied the inventory to ensure that each group received the same instructions. In order to facilitate scoring the papers, an answer sheet was prepared and used by the girls in checking their responses.

The total score for each girl was computed and used in preparing a frequency distribution. The girls toward the top of the frequency distribution were considered to have the more favorable attitude toward physical education as a career for women; the girls at the bottom of the distribution, a less favorable attitude. All those papers having scores within the top 27 percent of the distribution and the bottom 27 percent of the distribution were selected for use in checking the validity of the inventory and for use in the statistical analysis of the individual statements. The mean scores of both groups were computed and the critical ratio method used to determine whether or not there was a significant difference between the means.

Each individual statement on the inventory was then subjected to statistical analysis in order to eliminate those statements which were ambiguous or which failed to discriminate between those having a favorable or unfavorable

attitude toward physical education as a career for women. Thurstone's (4) method of testing for ambiguity was adapted for this use. According to Thurstone, a statement which elicited a wide range of responses from a judging group, as measured by the interquartile range, was considered ambiguous since the judges were unable to agree as to its position on the attitude scale. To determine this range, the Q value, Thurstone prepared a table of accumulative proportions based on the percentage of the judges who placed a statement at each point value on the scale.[1] The percentages at each point value were added to the sum of the percentages below it so that the accumulative proportions would run from the percentage given to the low scale value up to 100 percent at the top scale value. A graph was plotted using the scale values as the x-axis and the accumulative proportions as the y-axis. In adapting the technique to this study, the x-axis represented the numerical values of one through five and the y-axis represented the accumulative proportions of the girls in the upper 27 percent of the frequency table who checked each of the five possible answers. The process was then repeated using the lower 27 percent of the distribution. The ambiguity of a statement was found by dropping vertical lines from the first and third quartile points to the x-axis and noting the difference between their values. If this difference was greater than 2.25, the statement was judged ambiguous.

To find the discriminating power of each statement, Flanagan's Table (2) was used. For each item the percentage of students in the upper 27 percent of the combined frequency table who scored five on that statement was compared with the percentage of students from the lower 27 percent who also scored five. The item discrimination index was then read directly from the Flanagan Table. The higher this score, the better the statement was considered to differentiate between attitudes. For the purpose of this study, statements scoring less than 30 were dropped from the inventory as having poor discriminatory power.

After those statements which were ambiguous or inconsistent had been eliminated from the inventory, the split-half method of determining reliability was used with the remaining statements. The results of this correlation were raised by the Spearman-Brown formula for the total number of attitude statements.

Since a large number of statements remained on the inventory, it was decided to make two forms of the inventory for the purpose of before and after testing. As a first step, the items were listed under the specific areas of physical education which they covered. They were then divided into two forms so that each form covered all these areas. Care was taken to see that there were equal numbers of affirmative and negative statements on both forms. Each paper was then rescored for Form A and Form B (see Appendix) and the scores correlated to determine the similarity of the forms.

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[1]Thurstone used the symbol Q to represent the interquartile range. Although other statisticians have referred to Q as the quartile deviation, or semi-interquartile range, it is used here according to the meaning given it by Thurstone.

Analysis of Data

Although there is no absolute method of proving the validity of an attitude inventory, the use of the critical ratio method in this study indicated a significant difference between the mean scores of the highest 27 percent and the lowest 27 percent of the papers. The mean score of the top group was 383.07 with a standard deviation of 14.25. The mean of the bottom group was 286.66 with a standard deviation of 23.17. The critical ratio was 22.95 indicating that the inventory differentiated between the two groups at the .01 level of significance.

The use of Thurstone's method of testing for ambiguity resulted in the elimination of seven statements from the inventory. Three of these were among the 12 statements dropped from the inventory as having poor discriminatory power, making a total of 16 statements eliminated following the statistical analysis.

The split-half method of determining reliability provided a reliability coefficient of .93; when raised by the Spearman-Brown formula for the whole inventory, .96. As a further check on the reliability, the mean scores for the odd and even totals were computed and the critical ratio found. The mean for the odd scores was 138.95; for the even scores, 140.65. The critical ratio was .85 which proved statistically insignificant. After rescoring the papers for Form A and Form B, the two scores were correlated to determine the similarity of the forms. The product-moment correlation was +.87.

Conclusions

From an analysis of the data gathered in this study, the following conclusions were drawn:

1. If considered in view of the limitations inherent in all attitude studies, the scores obtained on this attitude inventory may be taken as an indication of the attitudes of high school girls toward physical education as a career for women.

2. Form A and Form B of the attitude inventory have given statistical evidence that they are a reliable means of measuring this attitude. The validity of these two forms is subject to the usual limitations of attitude studies, but the evidence in this particular study indicates that they do differentiate between those having a favorable attitude and those having an unfavorable attitude toward physical education as a career for women.

3. The similarity between Form A and Form B makes it possible to use these forms for the purpose of determining changes in attitude, using one before and one after an experimental factor has been introduced.

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Appendix

ATTITUDE INVENTORY—FORM A

1. Salaries of physical education teachers should not be as high as the salaries of those who teach academic courses.
2. Skills learned in physical education classes are essential in social life.
3. Physical education should be one of the first courses taken from the curriculum if a cut is necessary.
4. Teaching physical education is considered "unfeminine" for a woman.
5. A curriculum which does not include physical education does not offer a complete education.
6. Physical education cannot be considered a profession.
7. Academic requirements for majors in physical education are not as difficult as those for other college students.
8. Girls look forward to their physical education classes with enthusiasm.
9. Physical education offers little of importance in the education of young women today.
10. Physical education teachers show a sympathetic interest in the problems of their students.
11. Physical education classes provide excellent opportunities for making friends.
12. Physical education activities develop socially desirable standards of conduct.
13. Physical education teachers are only concerned with muscle building.
14. Physical education makes important contributions to mental health.
15. Physical education should be elective rather than required.
16. Physical education for leisure is as important as education for work.
17. Most parents would not approve of their daughters' majoring in physical education.
18. Physical education classes are not fitted to the individual student's interest.
19. Physical education teachers have pleasing personalities.
20. Physical education is one of the "fads" and "frills" of modern-day education.
21. There are many opportunities in the physical education program for the character development of the students.
22. Physical education teachers are not given the same respect by the public that other teachers receive.
23. Girls who excel in sports are not as intellectual as other girls.
24. By the time a girl reaches high school age she no longer needs physical exercise.
25. It should not be necessary for a woman to be a college graduate to teach physical education.
26. Physical education credit should be required for graduation from high school.
27. Teaching physical education would be a rewarding profession.
28. Intelligence is not as necessary as athletic skill for a teacher of physical education.
29. Women who teach physical education are well-groomed and attractive.
30. Competitive sports should be eliminated from the physical education curriculum.
31. Physical education contributes to the physical and mental development of the girls.
32. It is silly for high school girls to waste time playing games.
33. Physical education helps to develop poise.
34. Competition brings out the worst qualities in a person.
35. Grades in physical education are not fair to the non-athlete in comparison to the "natural athlete."
36. Girls do not require exercise in order to maintain organic health and vigor.

ATTITUDE INVENTORY—FORM B

1. Physical education offers training for leadership.
2. Informal recreation periods during the day would eliminate the need for required physical education classes.
3. Other members of the faculty consider the physical education teacher intellectually inferior.
4. "A strong back and a weak mind" are characteristics of physical education teachers.
5. Learning to play effectively together toward common goals is a major contribution of physical education.
6. There is no need to be concerned over the present shortage of women physical education teachers.
7. The expenditure of funds for "exercise" and "play" is unnecessary and wasteful.
8. There are many opportunities for the development of moral and ethical conduct in physical education.
9. Physical education is not worth the trouble involved in dressing for class.
10. Physical education activities provide opportunities for satisfying social experiences.
11. Participation in physical education is likely to result in accidents.
12. I would never want a daughter of mine to major in physical education.
13. Physical education contributes nothing of value to our culture.
14. Physical education affects the physical but not the mental development of the student.
15. Physical education should be a requirement from elementary school through high school.
16. Physical education provides an outlet for suppressed emotions.
17. Only girls who play well are wanted on intramural teams.
18. Every girl should develop to her greatest physical capacity.
19. Most girls do not enjoy physical education classes.
20. Girls with good grades in academic subjects should not be required to take physical education.
21. Educated people rarely take part in physical activities.
22. Women who teach physical education are not popular socially.
23. Physical education contributes to the total education of each student.
24. There is a large variety of interesting activities offered in the physical education program.
25. If physical education were an elective, I would elect it.
26. Everyone should keep physically fit through a regular program of exercise.
27. Physical education classes are fun.
28. Physical education contributes nothing of value to a student's general education.
29. Only two years of college should be required for physical education teachers.
30. Sportsmanship is no longer emphasized in physical education.
31. Physical education teachers are understanding and interested in their students as individuals.
32. There are many opportunities to make friends in a physical education class.
33. Good health habits are learned in physical education classes.
34. Physical education activities make a significant contribution to the development of an individual's personality.
35. Competitive sports provide opportunities for learning and practicing democratic behavior.
36. All girls should have the opportunity to develop some type of active recreational skills.

(Submitted 2/26/60)

Degree of Participation in Related Areas by Men Physical Education Majors in Five of the Illinois State Universities[1]

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Abstract

This study was conducted to determine the feasibility of measuring degrees of participation of physical education majors in areas closely related to their profession. Areas selected were intercollegiate and intramural sports and professional activities. Five universities in Illinois provided the basic information pertinent to the study involving 683 majors. An analysis of the information indicated a highly questionable degree of participation. The greatest amount of participation was in intercollegiate and intramural sports. The least amount of participation was in professional club activity and participation in the work of the state and national physical education organizations.

A QUESTION ALWAYS seems to arise concerning the amount of participation in areas related to physical education by our major students during their undergraduate years in college. There seems to be little disagreement on the part of professors and employers that active participation in several related areas is advantageous to the potential teacher and coach of physical education activities.

Three purposes for conducting this study were projected. The first and most important purpose was to devise a workable method whereby participation by physical education majors in related areas could be evaluated. This information would differentiate between the active and inactive major and could serve as one of several criteria for judging a major's worth to the profession and his potentiality as a teacher.

The second purpose was to see if such a method of evaluating participation could be extended to more than one university. In this instance five state universities in Illinois agreed to cooperate. It was believed that if this could be done, the profession, as well as the universities involved in such a study, could profit from the resulting information. The third purpose, contingent on the first two, was to analyze the information furnished by the five universities to see what pattern of participation was prevalent on an individual and collective school basis.

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[1] This study was initiated by the Research Committee of the Illinois Association for Health, Physical Education, and Recreation. Committee members were Robert McAdam, Helen Zimmerman, and William Groves.

Procedure for Obtaining Data

Representatives from five universities located in the state of Illinois were asked to cooperate in the study.[2] Each university offers teacher education for students, and the representatives of each institution were closely associated with those students whose major preparation was in undergraduate physical education.

Five master stencils were prepared and sent to each representative. The stencils included a check sheet and a sheet of instructions for the representative to follow. The majors at each university filled in the items to be checked. Data covered a two-year period. The representative spot-checked the check lists and returned them to the writer for analysis.

The check sheets from each university were tabulated by I.B.M. and evaluated according to a weighted scale of values. Two of the five universities were operating on the semester system. A correction measure was used to reconcile this difference in the evaluation procedure.

Areas of Participation

The related areas of participtpon by physical education majors selected for this study were ones that seemed to be typical of most teacher education curriculums, particularly among the five universities in the State of Illinois that joined in this study. The point-value for each area of participation was arbitrarily chosen with the greater weight allotted to intercollegiate and/or intramural sports. The reason for this was that most of the physical education majors graduating from the five universities participating in this study seek and are hired primarily for coaching duties. There was no attempt to minimize the importance of participation in professional areas by the potential teacher of physical education. Subsequent experience with majors, in application of the points brought out by this study, shows that counseling in this area is more successful than counseling in other areas.

Intercollegiate Sports. Participation in either regular competition or "B" team competition was scored of equal value. Equal points were awarded for participation as a player, trainer, or manager. Ten points were awarded for each season's competition provided it was a different sport each season. A major participating in three different sports during one academic year would earn a total of 30 points. Similar participation for the second year would earn an additional 30 points for an accrued total of 60 points.

Intramural Sports. Six points for participation as a manager, official, or player were awarded for each different sport over the two-year period. No limit was set as to the number of points that might be earned. For one academic year a major might participate in five different sports earning a total of 30 points. Identical participation the second year would earn the major

[2] These representatives were James Collie, Illinois Normal University; Mark Dean, Northern Illinois University; Warren Hoffman, University of Illinois; Guy Ricci, Western Illinois University; and Maynard O'Brien, Eastern Illinois University.

an additional total of 30 points. In this manner a major not out for intercollegiate sports would earn as many points as the major who was participating in three different intercollegiate sports for the two-year period.

Physical Education Major's Club, or Similiar Clubs. Majors, if very active, could earn 18 points for participation over a two-year period in a "Major's Club," "Dolphin Club," or some similar club related to physical education.

IAHPER Membership. A major could earn one point each year for membership in the IAHPER and one point each year for attendance at the state or district meetings for a possible total of four points.

AAHPER Membership. A major could earn one point each year for membership in the AAHPER and one point each year for attendance at the National or Midwest meetings for a possible total of four points.

American Red Cross Water Safety Instructor. A major could receive a total of two points for the two-year period if he was a water safety instructor.

IHSAA Membership. A major listed as an official of the Illinois High School Athletic Association could earn two points over the two-year period.

Method Used in Determining Degree of Participation

The maximum number of periods in which a major could earn points (excluding summer sessions) was six quarters or four semesters. The point values were determined so that a student in full attendance could total 100 points (100% participation) if he was very active. Such a student would participate fully in either intercollegiate or intramural sports or a combination of both. In addition, he would be active in club work and would belong to the state or national organization. A student participating in one intercollegiate sport for each of two years would total 20 points and thus be classified as inactive.

A weighting factor was used to equalize, on the basis of 100 points, the participation of an active freshman who was in attendance for only one quarter or semester during the two-year period. In addition, corrections were made for majors who might be enrolled in school but were off the campus doing student teaching. Working or commuting, checked by some as reasons for not participating, was not given any correction.

The categories shown in the tables listing participation as "Very Active," "Fairly Active," etc., were arbitrarily chosen.

Analysis of Results

Table 1 shows the number of majors in various categories participating in this study. It should be noted that these totals do not include all physical education majors enrolled at each university. The time allowed for completing the study was not sufficient to guarantee contact with every major in each school. One university apparently does not recognize freshman and sophomore majors.

TABLE 1.—NUMBER OF PHYSICAL EDUCATION MAJORS PARTICIPATING IN THE STUDY

Universities	Freshmen	Sophomores	Juniors	Seniors	Total Majors
All Universities	232	173	160	118	683
University No. 1	56	37	41	24	158
University No. 2	52	36	16	12	116
University No. 3	0	0	33	39	72
University No. 4	69	53	28	14	164
University No. 5	55	47	42	29	173

The data for Table 2 are based on the number of majors participating in the study. The participation score is the total weighed values a major had earned for participation during tne two-year period studied. The score is first shown in intervals of ten. Table 2a is an arbitrary attempt to reduce the data to four participation levels for easier interpretation. Table 2b is a further reduction of the data shown in Table 2.

It is interesting to note that 13 percent of all majors from the five schools did not earn a score above "0-9." If he had participated in one intramural activity each of the two years studied he would have earned at least twelve points. If he had participated in one intercollegiate sport for only one year he would have a total of 10 points. Eighty majors out of a total of 683 are considered to be very active, while 224 are shown to be inactive. If he had participated in three intramural sports for each of the two years studied, he would have earned 36 points.

Table 2b shows a further reduction where less than 50 participation points indicates relative inactivity. Listed as inactive are 420 majors, or 61 percent. A major would have earned 56 points by participating in one intercollegiate and three intramural sports during each of the two years.

The other data in these tables show similar participation comparisons by individual universities. The best record of participation is shown to be University No. 5, yet 54 percent of these majors are inactive.

One might assume that the high percentage of inactive participation, as shown in Table 2b, is due to the greater number of inactive freshmen majors. Table 3b shows, however, that all classes are more inactive than active except the seniors, and they barely exceed the 50 percent participation mark.

Table 3 shows the amount of participation by class where all freshmen from the five universities are combined as a group, all sophomores combined as a group, etc.

Table 3a shows that three classes are 30 percent inactive; the juniors are 24 percent inactive. It seems that many of our majors are becoming graduates with little background of participation in related areas.

Table 3b reveals that 70 percent of the freshmen and 65 percent of the sophomores are inactive. No matter what reasons may be conjectured for

TABLE 2.—COMBINED AND INDIVIDUAL UNIVERSITY PARTICIPATION LEVELS OF PHYSICAL EDUCATION MAJORS

	All Universities		University No. 1		University No. 2		University No. 3		University No. 4		University No. 5	
Participation Score	No. of Majors	Percentage	No. of Majors	Percentage	No. of Majors	Percentage	No. of Majors	Percentage	No. of Majors	Percentage	No. of Majors	Percentage
90-100	42	6%	17	11%	1	1%	1	1%	7	4%	16	9%
80-89	38	6%	9	6%	9	8%	1	1%	4	2%	15	9%
70-79	58	8%	9	6%	8	7%	9	13%	14	9%	18	10%
60-69	57	8%	16	10%	11	9%	5	7%	8	5%	17	10%
50-59	68	10%	20	13%	13	11%	9	13%	12	7%	14	8%
40-49	104	15%	21	13%	23	20%	9	13%	29	18%	22	13%
30-39	92	13%	25	15%	21	18%	15	21%	14	9%	17	10%
20-29	83	12%	18	11%	12	10%	11	15%	27	16%	15	9%
10-19	49	7%	6	4%	7	6%	3	4%	21	13%	12	7%
0-9	92	13%	17	11%	11	9%	9	13%	28	17%	27	16%

TABLE 2a. ADJUSTED LEVELS

Very active (80-100)	80	12%	26	17%	10	9%	2	2%	11	6%	31	18%
Fairly Active (50-79)	183	27%	45	28%	32	27%	23	33%	34	21%	49	28%
Active (30-49)	196	29%	46	29%	44	38%	24	34%	43	27%	39	23%
Inactive (0-29)	224	33%	41	26%	30	25%	23	32%	76	46%	54	32%

TABLE 2b. ADJUSTED LEVELS

Active (50-100)	263	39%	71	45%	42	36%	25	35%	42	27%	80	46%
Inactive (0-49)	420	61%	87	55%	74	64%	47	65%	119	73%	93	54%

TABLE 3.—PARTICIPATION LEVELS OF PHYSICAL EDUCATION MAJORS BY CLASS—ALL UNIVERSITIES

	All Freshmen		All Sophomores		All Juniors		All Seniors	
Participation Score	No. of Majors	Percentage	No. of Majors	Percentage	No. of Majors	Percentage	No. of Majors	Percentage
90-100	13	6%	4	2%	12	8%	13	11%
80-89	5	2%	9	3%	12	8%	12	10%
70-79	16	7%	14	8%	14	9%	14	12%
60-69	16	7%	13	8%	16	10%	12	10%
50-59	20	9%	21	12%	17	11%	10	8%
40-49	41	18%	27	16%	28	18%	8	7%
30-39	34	15%	22	13%	22	14%	14	12%
20-29	32	14%	25	14%	17	11%	11	9%
10-19	12	5%	18	10%	8	5%	9	8%
0-9	43	19%	20	12%	14	9%	15	13%

TABLE 3a. ADJUSTED LEVELS

Very Active (80-100)	18	8%	13	8%	24	15%	25	22%
Fairly Active (50-79)	52	22%	48	28%	47	29%	36	31%
Active (30-49)	75	32%	49	28%	50	31%	22	10%
Inactive (0-29)	87	38%	63	36%	39	24%	35	30%

TABLE 3b. ADJUSTED LEVELS

Active (50-100)	70	30%	61	35%	71	44%	61	52%
Inactive (0-49)	162	70%	112	65%	89	56%	57	48%

this large percentage of inactive participation, the fact remains that these two groups are being sadly neglected in some manner.

Table 4 shows the amount of participation of majors in areas closely associated with physical education activities. All majors from the five universities are grouped together with the percentage of participation shown for each category. The same relationship is shown for each individual university. Many of the majors participated in more than one activity.

The high percentage of participation in the intramural programs indicates the importance of such programs for physical education majors as well as for other students. All majors cannot be expected to have the ability to engage in intercollegiate sports. Majors who do participate in a specialized manner in one or two intercollegiate sports need a varied program in intramurals to become better versed in the field of sports activity.

It is gratifying to see that a fairly high percentage of the majors participate in intercollegiate sports.. Practically all men physical education majors may be expected to coach in some sport after graduation. Many of the majors, as shown in this study, do not participate in intercollegiate sports even when they are capable of doing so. For such students the intent to major in physical education might be seriously questioned.

While the two areas of intercollegiate and intramural sports are very important, it is disappointing to see the lack of professional interest, both by the student major and the university. Two universities had no club or organization that would tend to promote some phase of professional growth on the part of the major. Membership in a professional organization at the district, state, or national level was pathetically low.

Summary

1. Physical education majors, as a group, could be considerably more active in participating in areas closely related to physical education.
2. Participation tended to increase in degree as physical education majors progressed from freshman to senior status.
3. While participation of all classes of physical education majors seemed to be low, the freshman and sophomore groups were particularly low.
4. Intramural activity had the greatest participation followed closely by intercollegiate participation.
5. Participation in the letterman's club, physical education major's club, or similar club activity on the part of all physical education majors was very low. Two universities had no clubs in operation.
6. Participation by all physical education majors in the IAHPER and in the national organization was extremely low. One university had zero participation in this category.

Implications

The writer believes that our physical education majors should have varied experience in related areas of physical education activities aside from reg-

TABLE 4.—ACTIVITIES PARTICIPATED IN BY PHYSICAL EDUCATION MAJORS—COMBINED AND INDIVIDUAL UNIVERSITIES

Activity	All Universities		University No. 1		University No. 2		University No. 3		University No. 4		University No. 5	
	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage
Intercollegiate	386	57%	91	58%	67	58%	46	64%	81	49%	101	58%
Intramural	492	72%	125	79%	90	78%	50	69%	112	68%	115	66%
Letterman's Club	111	16%	26	16%	23	20%	21	29%	17	10%	24	14%
Physical Education Major or Similar Club[a]	135	39%	64	41%	52	45%	19	26%	—	—	—	—
IAHPER Membership	52	8%	28	18%	13	11%	6	8%	0	0%	5	3%
AAHPER Membership	73	11%	16	10%	6	5%	43	60%	1	1%	7	4%
Red Cross Water Safety Instructor	44	6%	9	6%	5	4%	14	19%	10	6%	6	3%
IHSAA Official	44	6%	12	8%	6	5%	3	4%	12	7%	11	6%

[a] Only three of the five universities had such a club for an overall total of 346 majors.

ular class work. From this standpoint the most significant contribution of the study is that participation and differentiation of degree of participation among physical education majors should and can be measured.

Experience with this form of measurement at the writer's university showed that the more active majors welcome such measurement. The less active, but still serious majors, showed an increased interest in becoming more active in participation when they observed that their record was being evaluated. Some boys changed their majors but it was not determined that evaluating their record was the cause for the change. Enrollment in the major's club tripled, and membership in the IAHPER increased greatly.

The director of the university's placement office expressed a desire to have more information on senior physical education majors than grade point average and personal recommendations. The same university has initiated a policy whereby a student planning to teach must be recommended by the departmental staff to which he is attached as a major. A recommendation is usually given during, or before, the sophomore year. It becomes difficult, at times, to give a recommendation to a student this early when 100 or more majors may have to be considered. A yearly record of each student major's participation should prove valuable to the student, to the department, to the placement office, and to the employer.

Colleges and universities should seriously evaluate all phases of a student major's progress in physical education, including participation in related areas. A prospective teacher or coach needs a strong professional sense of values and should be familiar with the "tools of his trade." The nonparticipating student major should be a conspicuous rarity in the field of physical education.

(Submitted 2/8/60)

Psychological Refractoriness and the Latency Time of Two Consecutive Motor Responses[1]

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Abstract

When the response movements are as short and simple as possible, the time lag between stimulus and response for one movement is shortened by introducing the stimulus for a second movement during the latent period for the first (usually about .22 sec.). Under these conditions the latent period of the second movement is increased about 25 percent. This does not seem to be caused by true psychological refractoriness, since ability to accept the second stimulus and respond to it is still present. A control experiment furnishes evidence that it is probably a foreperiod-expectancy phenomenon. The length of the response latency of a simple single movement is increased about 40 percent if conditions are altered so that a second stimulus requiring a second movement is expected some time within a half-second after the first stimulus. All of these results are consistent with the recent memory drum theory of neuromotor response.

WHEN A PERSON is required to react to each one of a succession of stimuli that are separated by relatively short time intervals (0.1 to 1.5 sec.), it has been observed that there is usually an interference in the response to a particular stimulus if another stimulus has preceded it within as short a period as 0.5 sec. Telford (9) in 1931 introduced the concept "Psychological Refractory Period" (PRP) to explain this interference.

Review of Literature and Theory

Craik (1) in 1948 recognized the importance of the PRP in his theoretical treatment of pursuit movements. Systematic experimental investigation of the phenomenon, however, began with the 1948 studies of Vince. Under the conditions of her first experiment (10), which involved using a pencil to follow a continuously moving line as viewed through a narrow vertical slit, subjects did not react consistently to the second of any two consecutive stimuli until the elapsed time after the first was 0.5 sec. or longer. From these results, she inferred that the inability to respond was caused by a psychological refractoriness. In a later study (11), where subjects reacted to a series of dots in a choice situation on a similarly moving band of paper, performance deteriorated when intervals were less than 0.3-0.5 sec. Because of the high error rates at short intervals, she concluded that the human being could not be expected to deal adequately with a series of discrete stimuli requiring separate responses unless they were spaced at intervals of at least 0.5 sec.

Welford (12) in 1952 criticized the earlier movement theories of Telford (9), Craik, Vince, and Poulton (7). He agreed with Hick's theorizing (5) that there is an overlap-

[1] From the Research Laboratory of the Department of Physical Education.

ping of reactions in the central nervous mechanism (even though the response to the first stimulus has been completed). The consequent result is that the second stimulus and its associated response have to be held-in-store until the subject is able to deal with them. He postulated that a definite organizing time is required to process a stimulus and select the appropriate response, thus leading to a presumed absolute refractoriness to any closely-following stimuli. He further held that this central delay would be influenced by stimulation fed back from a response, especially at the beginning and end of movement where there is rapid acceleration and deceleration. Thus he hypothesized that these mechanisms prevent subjects from reacting to the second stimulus whether in a discrete or a continuously changing situation.

In stating a memory drum theory for neuromotor control of movements, Henry (4) has taken a position that has differences as well as similarities compared with the ideas of Welford. He has hypothesized that fast discrete movements are guided by a nonconscious motor memory mechanism that furnishes a program. This program flows into the cephalic neural coordination centers where it guides the neural impulses through the appropriate sub-centers and channels to produce the movement. When the stimuli are simple and the response movements are short and uncomplicated, "minor program changes would be easy to accomplish" because the time required for programming the movement would constitute only a part of the total latency or reaction time. However, a movement that is complicated or requires neuromotor control for a relatively long period would exhibit a long reaction time, because a longer and more comprehensive program, requiring a more extensive withdrawal of stored information from the motor memory system, would be needed in this case. "A complicated program should be difficult to change, once it starts organizing the channels" of neuromotor response (4). While Henry has not explicitly discussed the PRP, it would seem to follow from his concepts that, contrary to the experimental evidence of Vince and others who have found high error rates and inability to respond in serial reactions when the interstimulus interval is short (well below 0.5 sec.), he expects few errors, even for the small interstimulus intervals, when the movement for the first stimulus is short and simple. However, if the movement required by the first stimulus is long or complicated, he holds that there will be refractoriness which will interfere with the response to the second stimulus of the pair.

Davis (2) has indicated that the PRP (if refractoriness is defined as the lengthening of the RT for the second of a pair of stimuli) may not be as long as indicated by the results of Vince and other investigators. His two subjects (each tested under a different condition) pressed keys in response to visual stimuli on a moving paper band. The results showed an inverse relationship between the second RT and the interval between the stimuli, i.e., whenever a second stimulus was presented before the completion of the first response, the second RT was lengthened progressively as the interstimulus interval was shortened. Whenever the interval was greater than the first RT, no such lengthening was found. The first RT's of the paired responses were similar in length to normal RT's obtained in a control experiment. Davis theorized that the amount of motor control necessary for a particular response determined to a great extent the duration of the PRP (thus explaining discrepancies between his and earlier findings). He considered that in the performance of more complex tasks, kinesthetic feedback stimuli may be necessary to exercise controlled movements and the amount of information required to perform the task may determine the duration of the refractoriness.

Slater-Hammel (8) has recently reported a more comprehensive experiment using the variables studied by Davis. His results showed that lengthening of the second RT in paired responses occurred throughout the range of 0.05 to 0.50 sec. between stimuli. For interstimulus intervals that were shorter than the length of the first RT, the increases in length of the second RT were inversely related to the interstimulus intervals. The first of the two RT's in the paired responses was longer than the normal single RT for the same stimulus and response.

Problem Investigated

The present study is primarily concerned with testing the Henry hypothesis that the PRP (defined as the refractoriness of the subject with respect to accepting and reacting to the second of a pair of stimuli that are close together) is absent when the first stimulus and response are unvarying and are of the simple RT type, and the response movement to the second stimulus is as short as possible. To test this hypothesis, there must always be presented to the subject both a first and second stimulus; the crucial question is whether the response to the second is absent, or occurs only part of the time, when the interstimulus interval is short, i.e., considerably less than 0.50 sec.

The study is also concerned with the influence of short interstimulus intervals on the RT for the second stimulus. A lengthening of this second RT might be interpreted as a relative refractoriness, or as an interaction between the neural events involved in the making of the two response movements. This is a complicated question; it is hoped that the data will throw additional light on it.

In planning the experiment, it was considered essential to minimize the possibility of grouped responses which can occur when both of the two stimuli are presented within an interval that is no greater than the RT for the first stimulus. (Other investigators, notably Welford, have been concerned with the possibility of such grouped responses in PRP experiments.) Unless the experiment is designed to prevent it, the subject can react to the two stimuli as a unit, making a unitary one-two response to the one-two stimulus pair. In the writer's opinion, the use of a small proportion of catch trials, as done for example by Davis, does not offer adequate protection against this possibility. It would seem safer to require that each of the two stimuli be operationally identified by the subject on each trial, as verified by the use of appropriate response methods. The method for accomplishing this will be explained below.

Methodology

Apparatus. The reaction board (diagramed in Figure I) was placed horizontally on a table approximately 50 cm. in front of the subject, who rested his index finger on the reaction key R-I, (set flush in the board). The warning light W flashed on, and after a lapse of 1 to 3 sec. (in chance order) the first stimulus light S-I came on. The subject reacted by pressing R-I, which then remained locked down. After a predetermined interstimulus time interval, stimulus S-II came on. This stimulus consisted of a light; it was either L_1 or L_2, as determined by a random ordering. The subject responded to S-I by sliding his finger a few mm. either left or right (depending on whether the S-II light was L_1 or L_2). The sliding of the finger constituted response R-II, which was terminated by the appropriate finger post (1 or 2) which projected 15 mm. above the surface of the panel. Each post was attached to the lever of a microswitch mounted under the reaction board, so that a slight lateral pressure of the finger moved it a distance sufficient to operate the

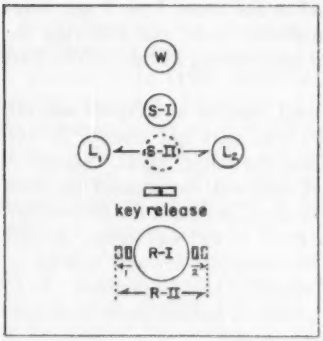

FIGURE I. Diagram of the reaction board. The warning light W came on first. It was followed by the stimulus light S-I, and (after a predetermined delay) by the second stimulus light S-II (which might be either L_1 or L_2). The subject reacted by pressing R-I (which then locked down); he reacted to S-II by making the response movement R-II, which consisted of sliding his finger laterally against one of the projecting posts 1 or 2 (depending on whether S-II came from L_1 or L_2).

microswitch. All of the signal lights were of the miniature neon type. The light W was of a distinctive shape and intensity so that it could easily be identified as the warning light and could serve as a fixation point during the stimulus series. Lights L_1 and L_2 were separated by a distance of 75 mm. Considering the distance from the subject, these lights could easily be identified as left or right, but were still close enough to the center line to be visible during fixation on W and S-I.

Reaction times (RT) were measured by three electric chronoscopes of known dependability (3), read to .01 sec. An electronic timing device controlled the various lights automatically. Before each reaction, the experimenter dialed the desired warning interval, the desired interval between S-I and S-II, and the desired choice of right or left for S-II, using randomized order sheets prepared in advance. The interstimulus interval between S-I and S-II was varied randomly; the times used were 0.05 to 0.20 sec. in steps of 0.05, and 0.20 to 0.60 sec. in steps of 0.10.

Types of Data. The first type of data, designated Normal RT (and not to be confused with the RT-I explained next) was the simple response to S-I when it was measured in isolation, with no other associated stimuli or responses.

The second type of data, obtained under the PRP situation, involved the measurement, in one continuous sequence, of both RT-I (the simple RT for S-I) and RT-II (the disjunctive RT for S-II when this stimulus was preceded 0.05 to 0.60 earlier by S-I).

The third type of data, designated RT-III, was the same as RT-II except that there was no movement in response to S-I and consequently no measurement of RT-I. The key R-I was kept locked down. The subject was informed that S-I required no movement, but that L_1 or L_2 would flash on with a variable delay (0.05 to 0.60 sec.) after the appearance of S-I, and would require the appropriate movement (finger left or finger right).

The fourth type of data, designated RT-IV, consisted of the same disjunctive RT as RT-II and RT-III, except that there was no S-I stimulus at all. The

subject had the warning signal, followed (after the usual 1 to 3 sec. foreperiod) by the lighting of either L_1 or L_2 in change order and requiring the left or right finger movement. There was no involvement of the 0.05 to 0.60 interstimulus delay period.

Subjects and Experimental Design. The total number of subjects was 60. All were male university students, volunteers who were not selected in any particular way. The average age was 23 years, the range, 18-33. Sample A ($N = 40$) was tested first; the third type of data was not secured on these individuals. A critical reexamination of the problem indicated the desirability of securing information on RT-III, so Sample B ($N = 20$) was tested. As will be seen in the tables, the total N available for statistical analysis was 20 or 40 or 60 depending on the particular set of variables being examined. As to age, method of securing subjects, and other pertinent factors, there is no reason to suspect any difference between the two samples.

Within each sample of subjects, the order of testing with respect to the different types of data was randomly determined for each person on a closed population basis to ensure a balanced order. The experimenter allowed as many practice trials as were in his judgment necessary to ensure that the subject was performing the test properly. The order of presenting trials involving the various interstimulus intervals was randomized. Each subject was given 60 trials for each of the types of data that were secured for his sample. Other details of the experimental design should be evident from the tables and the presentation of results.

Results

The classical experiments on the psychological refractory period emphasized the relative inability of the subject to accept and respond to the second of two RT stimuli when it followed too closely on the first. The primary evidence for refractoriness is held to be absence or incorrectness of response to the second stimulus, although lengthening of the second RT may possibly indicate some sort of interference between the two, and may or may not be caused by true refractoriness.

TABLE 1.—ERROR RATES PER 100 RESPONSES IN BOTH RT-II AND RT-III

Interstimulus Delay (sec.)	RT-II (PRP Situation)			RT-III
	Sample A ($N = 40$)	Sample B ($N = 20$)	A+B Combined ($N = 60$)	Sample B ($N = 20$)
0.05	2.50	1.25	2.08	0.00
0.10	1.16	0.91	1.08	1.82
0.15	1.42	0.56	1.13	1.67
0.20	3.62	2.12	3.12	4.15
0.30	11.26	6.56	9.69	0.72
0.40	11.00	10.00	10.67	5.00
0.50	7.38	7.36	7.37	3.13
0.60	8.75	10.00	9.17	2.50

Error Rates. In the present experiment, an error is defined as the choosing of the incorrect direction of the finger movement in response to stimulus II-L_1 or stimulus II-L_2 (PRP situation). Errors are given in Table 1 as the rate per 100 responses. Inspection of the data for the different delays reveals that the maximum error rates, which are never very high, occur at relatively long delays (0.30 and 0.40 sec.) and remain at approximately this value with even longer delays. The error rates are low for the short delays. The pattern is almost identical for subjects in both Samples A and B for RT-II. A similar pattern is observed for RT-III, although the error rates are lower and are more variable. There are no errors in RT-I (the response which preceded RT-II). Thus complete failure to respond, in the case of either RT-I or RT-II, did not occur. Rarely (less than once per 360 reactions) did the finger slip off the reaction key during the response; such trials were discarded.

TABLE 2.—VARIANCE ANALYSES OF ERROR RATES

Source of Variance	RT-II (PRP situation)			RT-III		
	df	MS[a]	F	df	MS[a]	F
Total SS	479	1.160	1.39	159	0.306	.....
Subjects	59	1.370	.....	19	0.298	1.02
Delays	7	10.045	10.25	7	0.566	1.93
Error	413	0.979	.....	133	0.293	.....

[a] The units are in errors per 100 responses. The F-ratio required for a significant delay effect for RT-II is 2.03; for RT-III it is 2.08. Here and later, the criterion for statistical significance is taken at the 5 percent level.

The two samples (A and B) have been pooled to give data on 60 individuals for a variance analysis of RT-II errors (Table 2). The F-ratio for the delays is significant. A computation of the required difference for significance in mean errors for the different delays shows that a 3.6 difference in error rates is required for a t-ratio that is significant at the 5 percent level (6). Using this criterion, it is found that the mean rates (Table 1) do not differ significantly among delays of 0.20 sec. or shorter, or among delays of 0.30 sec. or longer. There is, however, a significant jump in error rate between the delays of 0.20 and 0.30 sec. ($t = 3.9$). A variance analysis of the RT-III data is also given in Table 2. The F-ratio for delays is not quite statistically significant in this case ($F = 1.93$ compared with 2.08 required for the 5% level). It should be remembered that in this analysis there are only 20 subjects, while in the case of RT-II there are 60.

Reaction Times. Mean RT's for the PRP situation and the RT-III situation are given in Table 3 as a function of the interstimulus delay period. A graphic comparison of these data will be given later; for the present it is sufficient to call attention to certain apparent tendencies. RT-I changes very little as the delay is varied; it seems to be somewhat smaller at the shorter delays. There is a much larger change in RT-II; it is smallest at the longest delay, where it is almost identical with RT-IV, and becomes progressively larger up

to the shortest delay, where it has become 39 percent greater. RT-III is almost the same as RT-II at the longer delays. The lengthening of RT-III is less (only 22%), although there is a definite progressive tendency for it to lengthen at the shorter stimulus delay periods.

These data on RT's have been examined by the analysis of variance method, as shown in Tables 4 and 5. Since all the F's show statistical significance, the trends and differences described above are verified. The t-ratio test shows that the decrease in RT-I at the short delays is significant between the delay intervals 0.20 and 0.30 sec.; however, there is no significant effect for differ-

TABLE 3.—MEAN RT'S IN DIFFERENT TYPES OF EXPERIMENTAL SITUATIONS[a]

Interstimulus Delay (sec.)	PRP Situation		RT-II minus		RT-II[b] minus
	RT-I	RT-II	RT-IV[b]	RT-III[b]	RT-III[b]
0.05	0.225[b]	0.349	.....	0.296	0.053
0.10	0.219	0.304	0.052	0.264	0.042
0.15	0.223	0.292	0.040	0.255	0.051
0.20	0.224	0.279	0.027	0.252	0.032
0.30	0.232	0.276	0.024	0.253	0.032
0.40	0.234	0.263	0.011	0.247	0.009
0.50	0.238	0.254	0.002	0.244	0.005
0.60	0.230	0.251	—0.001	0.243	—0.010

[a] The average RT-IV, tested in a non-PRP situation was 0.252 sec. All values in the table are in sec.
[b] Using Sample B (N = 20). Other entries based on N = 60.

TABLE 4.—VARIANCE ANALYSES OF RT-I AND RT-II

Source of Variance	RT-I			RT-II			RT-I *vs.* RT-II	
	df	MS[a]	F	MS[a]	F	df	MS[a]	F
Total SS	419	17.946	.....	12.120	.....	829	20.181	.....
Type	.....	.....	.....	.....	.....	1	4334.020	838.99
Subjects	59	83.168	11.99	44.922	13.24	59	82.710	16.01
Subj. x type	.....	.....	.....	.....	.....	*59*	*45.380*	*8.78*
Delays	6	26.033	3.75	204.495	60.29	6	52.178	10.10
Delay x type	.....	.....	.....	.....	.....	*6*	*178.350*	*34.52*
Error	354	6.939	.....	3.392	.....	708	5.166	.....

[a] The units are in hundredths of a second. All F-ratios are statistically significant.

TABLE 5.—VARIANCE ANALYSES OF RT-II AND RT-III

Source of Variance	RT-II			RT-III			RT-II *vs.* RT-III	
	df	MS[a]	F	MS[a]	F	df	MS[a]	F
Total SS	159	16.334	.....	6.681	.....	319	17.948	.....
Type	.....	.....	.....	.....	.....	1	536.000	91.32
Subjects	19	62.909	10.63	16.603	6.81	19	58.052	9.89
Subj. x type	.....	.....	.....	.....	.....	*19*	*21.460*	*3.66*
Delays	7	242.132	40.93	60.351	24.74	7	266.312	45.37
Delay x type	.....	.....	.....	.....	.....	*7*	*36.171*	*6.16*
Error	133	5.916	.....	2.439	.....	266	5.869	.....

[a] The units are in hundredths of a second. All F-ratios are statistically significant.

ences in the delays that are less than 0.20 and more than 0.30. This can be understood by reference to Figure II, which uses as a reference point the occurrence of stimulus S-I, with the secondary reference stimulus S-II indicated by the diagonal line. In this figure, it can be seen that the decrease in RT-I has occurred only during the reactions when S-II has been given while the subject is still engaged in making R-I in response to S-I.

Another point of view is gained by examination of Figure II. The broken line labeled "projected RT-I" shows the RT-I's graphed as a distance from the diagonal line representing stimulus S-II, so that they can be compared visually with RT-II and RT-III. For interstimulus delays of 0.40 sec. or longer there is no appreciable difference between the projected R-I and R-II or R-III. The aforementioned shortening of RT-I is in evidence for delays shorter than 0.30 sec. In the case of RT-III, a t-ratio test of the differential effect of altering delay periods shows that the very short delays cause significant lengthening of the RT, but the differential effect for delays greater than 0.20 sec. is not significant step by step. There is a trend, however, and the difference between the RT's for 0.20 and 0.60 sec. is significant.

The graph shows clearly that the progressive lengthening of RT-II is slight or absent for delay intervals of 0.40 sec. or more. As the interval is shortened, step by step, below this amount, each successive step has a significant effect (as determined by the t-ratio test based on the error term of the variance

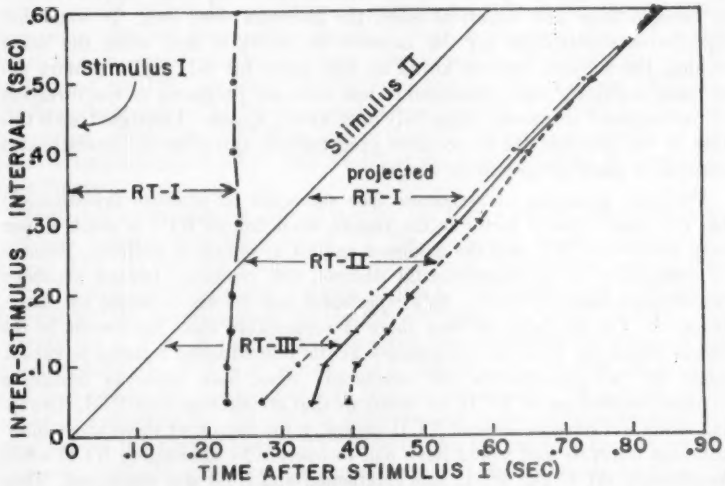

FIGURE II. Temporal relations of the two stimuli and the mean responses to them. Stimulus I occurred at time zero (vertical axis). The diagonal line shows when Stimulus II appeared. The RT's are represented by the distances between the stimulus lines and the corresponding response lines. The types of RT's are explained in the text.

analysis) with the single exception of the region from 0.30 to 0.20 where there is no change in RT-II.

Comparison with Normal Reactions. The mean for the normal simple RT in this experiment is 0.158 sec., whereas the mean RT-I is 0.228 sec. and varies from 0.219 to 0.238, depending on the interstimulus interval for the following S-II. Thus, the shortest mean RT-I is 39 percent longer than the normal simple RT, and the difference between these conditions is in this case significant ($t = 11.1$), even though RT-I is by ordinary definition a simple RT. This will be discussed later.

Similarly, the mean value of 0.252 sec. for RT-IV, the normal disjunctive RT, can be compared with RT-II. The differences are not significant when the interstimulus delays are 0.60 sec. ($t = 0.3$) or 0.50 sec. (0.7), although they do become significant as RT-II lengthens under the influence of the shorter delays.

Discussion

The evidence on error rates confirms the hypothesis. There is no refractoriness for short interstimulus intervals when the response movment for the first stimulus is short and simple as in this study. A significant number of errors does occur, however, for the relatively long intervals. For these same long intervals, the subjects are progressively reacting faster to the second stimulus. During the experiment, the writer noticed that many subjects tended to become tense and impatient when the intervals were long. A somewhat speculative explanation for the increase in errors is that when the delay is long, the subjects become keyed up and eager for S-II and are more apt to make a quicker and consequently less accurate judgment of the direction of the required movement when S-II does finally appear. Consistent with this idea is the fact that RT-II becomes progressively faster as the interstimulus interval is made progressively longer.

Probably grouping of responses (see statement of problem investigated) has not been a major factor in the results, even though RT-I is much slower than the normal RT, and the evidence against grouping is indirect. Because of differences in the experimental designs, any tendency toward grouping should have been different in this experiment and the one reported by Slater-Hammel. Yet the facts are that there is remarkably close agreement in the values found for RT-I and its changes as the interstimulus interval is varied, when the two experiments are compared. Also, both agree in finding a marked lengthening of RT-II for intervals that are shorter than RT-I. Grouping could not have influenced RT-II except in the region of these short interstimulus intervals and would have had to operate by shortening RT-II while lengthening RT-I. But RT-II was lengthened and RT-I was shortened. Thus it would seem that while a tendency to attempt grouping of responses could have been one of the factors responsible for causing RT-I to be so much longer than the corresponding normal RT at all intervals, it is most unlikely that it was involved in causing the lengthening of RT-II at short intervals.

The evidence seems clear that the latency period of R-I is lessened at short interstimulus intervals. This is interpreted by the writer as being a facilitation phenomenon, consistent with the Henry theory. The appearance of S-II, during the period of latency between S-I and R-I, somehow causes the R-T phase of the program to clear more rapidly; S-II is accepted and responded to without appreciable error. Apparently this phenomenon has not been observed by other investigators except Slater-Hammel, who noted without comment that such a tendency was present but was not statistically significant. In his experiment, the normal RT response was a key lift, while in the present experiment it was a key press, which is a more natural direction of finger response and seems to be faster. There were also a number of other differences in the two experiments, so the relatively faster normal RT found in the present study does not constitute disagreement.

Unquestionably, there is an increased latency of R-II when the interstimulus interval is very short (0.05 to 0.15 sec.); the present findings agree with the results of others on this point. Poulton, using different experimental conditions, has explained this as representing a foreperiod-expectancy phenomena rather than a true refractoriness. The RT-III data are consistent with this explanation. In measuring RT-III, the subject was given S-I, but made no movement in response to it. He knew that S-II would occur, but did not know just where it would fall except that it would be within the range of possible interstimulus intervals (0.05 to 0.60 sec.). As in any foreperiod situation, the subject would tend to be caught in an unprepared state if the stimulus came very soon after the preparatory signal. It may be assumed that S-I would function as a second warning or preparatory signal for the imminence of S-II in both of the PRP situation (RT-II) and the control situation (RT-III). While perhaps not all of the increased latency can be accounted for by this foreperiod effect (since RT-II is longer than RT-III), the similarity of the relative lengthening of RT-II and RT-III at the short intervals is impressive (see Figure II).

While not constituting a crucial test for the Henry theory, the increase in response latency from the normal RT (in isolation) to the considerably longer RT-I (in the PRP situation) is not logically inconsistent with it. The normal RT involves only the pressing of the key in response to a stimulus. In contrast, the sequence S-I—R-I in the PRP situation always involves the expectation of S-II. It may be hypothesized that a preliminary phase of the program for S-II—R-II is developed, but is held in store (as Hick contended) and does not go into action until S-II does overtly appear. Thus, right at the outset, the program for S-I—R-I is different and more complicated than the program for the normal simple RT. This is why the reaction time is longer. However, when the time of actual appearance of S-II is delayed, the program gradually dissipates, i.e., there is a loss of readiness. Thus, when the interstimulus intervals are long, RT-II is the same as the normal disjunctive reaction RT-IV.

In the Slater-Hammel experiment, RT-II started to become longer again

when the interstimulus interval was greater than 0.30 sec. He has explained this as probably caused by an expectancy arising from his use of catch tests, so his findings are not necessarily at odds with the present results. Another point of difference is that his subjects used different hands for RT-I and RT-II, whereas both reactions were made by the same hand in the present study. There were also other differences in the details of the experiments.

Conclusions

The inferences and generalizations based on the factual data that have been presented are, of course, limited to the conditions of the experiment. The following conclusions appear to be justified:

1. As predicted by theory, there is no true refractoriness in responding to the second of a pair of adjacent discrete stimuli, when the response movement for the first is as short and as simple as possible.
2. If the second stimulus of a pair occurs before the start of the movement in response to the first, there is a facilitation of the first reaction.
3. Response latency for the second stimulus is considerably lengthened if the interstimulus interval is short, probably because of a foreperiod-expectancy phenomenon. This effect dissipates within a few tenths of a second, leading to normal reaction times when the interval is a half-second or longer.
4. The reaction latency for the first of a pair of stimuli is increased in comparison with a normal reaction, probably as a result of the preparatory phenomena required for the second reaction.

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(Submitted 2/24/60)

Problem-Solving Test of Sportsmanship[1]

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Abstract

This study deals with the development and validation of two written tests of sportsmanship responses. The major steps followed were: selection of test items, development of criterion instruments, refinement and validation of test forms, and establishment of reliabilities between the forms. Validities and reliabilities were satisfactory, and the tests provided nearly normal distributions among responses.

A COMMONLY ACCEPTED objective of physical education is to teach and provide practice in ethical value formation. Physical education activities are rich in situations which involve ethical judgments, the resultant behavior being designated as sportsmanlike or unsportsmanlike. Teachers of physical education and sports should attempt to take advantage of such situations when they arise in the course of their classes, and they should plan to make situations occur which will require ethical value judgments. The former, however, is at best hit and miss, and the latter is difficult to accomplish. Too often ethical value formation is a casual by-product of the program, without special programs or planning to achieve it.

A major deterrent to the development of planned programs is the difficulty of measuring the qualities of sportsmanship. It was the purpose of this study to construct two equivalent tests of sportsmanship responses, which would serve as a measuring device as well as a useful teaching aid.

Sportsmanship is a quality which defies exact definition. We can be most accurate when we attempt to determine sportsmanlike behavior in a specific situation. Determining proper behavior in specific situations can lead to generalizations which can be applied in other instances in sports and other life situations.

Procedure

A group of 123 sports situations[2] involving ethical conduct, each with from three to eight alternative answers, were submitted to a jury of three men and two women physical educators including an administrator, an instructor of sports activities, an instructor of dance and sports, a physical education instructor who is also a coach, and a professor of physical education who is an official. The jury was asked to choose the alternative answers

[1] This study was made in partial fulfillment of the requirements for the Doctor of Philosophy degree at Ohio State University, under the direction of Delbert Oberteuffer, with statistical procedures under the supervision of Robert J. Wherry.

[2] These situations were accumulated by Betty G. Hartman, MacMurray College, in a previous study.

which they considered to exemplify the best sportsmanship, to choose four alternatives to accompany their choice, and to suggest additional alternatives for those situations having fewer than five.

Sixty items were selected on the basis of 80 to 100 percent agreement by the jury on the best answer. These were administered in test form to 80 professional women students in physical education and to 120 men and women students in the physical education basic instruction classes at Ohio State University, for the purpose of selecting discriminating items to be used in a written test of sportsmanship responses. The following are examples of test items:

Two rival teams in a well-known conference played a basketball game on one of these team's home court. During this game, the visiting team's star player was consistently booed whenever he missed a basket, pass, rebound, or maneuver. In the return game on the other team's court, the home crowd took revenge by booing all the players on the opposition. They were retaliating for what the other team's home crowd had done to their star.

a. Booing is a good device to use to rattle a player. If this could help the home team in the first game, such action is all right.

b. "Getting back" at the other team during the return game was justifiable under the circumstances.

c. Even though the star player had been booed, the other team's crowd should not have paid them back.

d. Booing individual players does more good than booing the whole team. In the second game, the spectators should have singled out one player.

e. Players should learn to play under difficult situations. Having the crowd boo them helps them to ignore future experiences of the same nature.

Player A is playing Player B in a tennis match. Player A beats B in the first set, 6 games to 1. Player B continually stops to tie his shoes, wipes his face every few minutes, and moves slowly into position for each play. Player B discovers that these actions upset player A. He continues these maneuvers and beats player A in the second and third sets, winning the match.

a. Player B is clever to use these tactics since they helped him win.

b. Player A should use the same tactics against player B.

c. Player B should not take unfair advantage of player A.

d. Since player A could use the same tactics as player B, player B was right to use them.

e. Player A, if he were a good player, would not let player B's tactics bother him.

As a first step in the validation of the sportsmanship test it seemed desirable to ascertain if possible how students prejudged each other with reference to their general understanding and judgment inherent in sportsmanlike behavior. In an attempt to do this, two sociometric instruments were devised and administered to the same professional women students. The first instrument (see Appendix), requiring each student to rate each other student, worked well with the older students who knew each other well. The second instrument (see Appendix) was most satisfactory with the freshmen and sophomore students since it required only that the raters select those of their classmates whom they considered would respond most or least favorably in a sportsmanship situation.

A measure of friendship, included in the second validity instrument, was partialed out of the sportsmanship ratings, and intelligence, represented by performance on the Ohio State Psychological Examination, was partialed out of test scores in an attempt to remove these influences from the score. This procedure,[3] however, lowered validities already obtained between sportsmanship ratings and test scores. It would seem that sportsmanship and friendship intercorrelate, or that good sports tend to be well liked and vice versa. Also, intelligence seems to have a bearing on sportsmanship responses, at least in a written test. Raw scores gave the best results in all cases.

An item analysis of test answers of the major group and of the basic instruction group served to eliminate 20 test items which did not differentiate one alternative. Weights were assigned alternatives on the basis of the item analysis but they did not improve validities. Their value is considered to be in their use in discussion.

Correlations between scores on the 40 test items and sportsmanship ratings were positive for the three criterion groups and significant at the 5 percent level for two of the groups.

Alternate forms of the test were constructed[4] and reliability correlations were run. All forms were reliable at the 5 percent level of significance; three of the four groups produced reliabilities at the 1 percent level. All raised reliabilities were significant at the 1 percent level. Validities, reliabilities, and significance levels of the 40-item test and of forms A and B are given in Table 1.

The results from the sophomore group cannot be explained satisfactorily. Groups which vary from the norms in this manner occur occasionally in statistical studies. Since the other groups conformed, it should be fairly safe to assume that this group was the exception rather than the rule. This is not to discount the possible significance of these results, but further experimentation is needed to determine that significance.

Means and standard deviations computed for all test forms are given in Table 2.

All means were above the midpoints of the tests. The scores of the physical education majors averaged higher than those of the service class group, probably because they were a select group. The means of the service group on test forms A and B were 1.60 and 2.45 points above the midpoints of the

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[3] Scores were predicted from intelligence by use of regression equations and subtracted from test scores. Correlations were then computed between sportsmanship ratings and the remaining scores.

[4] The test has been published under the title *Action-Choice Tests for Competitive Sports Situations* by Mary Jane Haskins and Betty Grant Hartman. It may be obtained by writing to Mary Jane Haskins, Department of Physical Education, Ohio State University, Columbus 10, Ohio, or to Betty G. Hartman, Department of Physical Education for Women, MacMurray College, Jacksonville, Illinois. Prices are: 30¢ per set for 25 or more (a set includes Form A, Form B, and keys); $1.00 per set for single copies; answer sheets 1¢ each (answer sheets may be used for either form).

TABLE 1.—COEFFICIENTS OF CORRELATION AND SIGNIFICANCE LEVELS OF THE 40 ITEM TEST, AND OF FORMS A AND B OF THE TEST

Tests	Freshmen	Sophomores	Juniors	Service
Validity 40 Items	.41[a]	.11	.66[a]	
Validity Form A	.43[a]	.08	.65[a]	
Validity Form B	.39[a]	.14	.62[a]	
Reliability Form A—Form B	.94[b]	.52[a]	.86[b]	.88[b]
Raised Reliabilities	.97[b]	.68[b]	.92[b]	.93[b]

[a] Significant at the 5 percent level.
[b] Significant at the 1 percent level.
All correlations were Pearson Product Moment r's.

TABLE 2.—MEANS AND STANDARD DEVIATIONS OF ALL TEST FORMS

Test Forms	Freshmen		Sophomores		Juniors		Service	
	Means	S.D.	Means	S.D.	Means	S.D.	Means	S.D.
40 Items	27.54	6.55	30.04	4.14	29.84	6.64	24.05	5.32
Form A	13.67	2.98	14.52	2.37	15.15	3.25	11.60	3.71
Form B	13.87	3.64	15.52	5.48	14.69	3.62	12.45	3.80

tests (10 out of a possible 20 points). Scores on test form B averaged slightly higher than scores on form A with the exception of the junior majors. Possible variations of the true statistics from those obtained were slight.

Discussion

This study has produced two tests of 20 items each which are reliable and valid insofar as the criterion instruments measure the qualities of sportsmanship. The limitations of the criteria are recognized but a dearth of more reliable instruments made their construction necessary. Since there is no universally accepted definition of sportsmanship, judgments based on individual philosophies are probably as valid measurements as can be obtained at this time.

Partialing friendship out of sportsmanship ratings and intelligence out of test scores lowered obtained validities on raw scores. This would seem to indicate that friendship intercorrelates with sportsmanship ratings, and intelligence with written scores. Sportsmanship stands high in the values of our culture; a person's reputation as a good or poor sport would influence the esteem in which he is held by others. Intelligence plays a part not only in the understanding and command of the written word but also in the ability to build concepts and generalizations, which in turn become bases for reasoning and choice of action in situations involving sportsmanship and ethics.

Weighting alternatives did not add to the validities of the tests, although a different system of weights could possibly do so. However, the writer does not feel that any system of weights would raise validities significantly. The values which could be derived from weighting alternatives lie in their use in discussion of test items, and in their possible future use in the development

of a profile based on the factors, as yet undetermined, which may make up the general quality we call sportsmanship.

The test forms achieved very nearly normal distributions among the service class group, with means close to the midpoints of possible scores. Differences between forms A and B are small but indicate form A to be slightly superior to form B in that it produced a higher validity, and means nearer the midpoint of the test.

Certain restrictions are inherent in the test. These are written, problem-solving, multiple-choice items. The tests purport to measure sportsmanship attitudes and knowledge, with the degree of emotional response determined by the student's experience in similar situations and his ability to relate test items to his experience.

Test scores would not necessarily indicate the degree of sportsmanship to be expected in a sports situation with its accompanying pressures and emotional involvements. A student might know the best response but fail to react in the same manner in an actual situation. The sportsmanship ratings given by classmates were based on observed behavior, and this would allow for some discrepancies between ratings and test scores based on knowledge.

Knowledge alone does not guarantee results in action, but knowledge must accompany attitude formation and precede action. If the student does not know what is right in a specific situation and has not conceptualized specific instances into principles, we can hardly expect him to respond favorably in a stress situation involving those knowledges and principles. The greatest values of the tests will be those obtained from their use as teaching aids, as stimulants to discussion, and as bases for generalizations on ethical behavior not only in sport but in all facets of life. The tests resulting from this study can be used to reinforce learning of appropriate behavior in sports situations, as part of planned efforts to teach sportsmanship.

Appendix

FIRST CRITERION INSTRUMENT

Directions

On a separate sheet you will find the name of every student in your group. We want you to put a number in front of every name. Put the number 3 in front of your own name.

Are there people in this group whom you think have exceptionally high standards of sportsmanship. If so, place the number 4 in front of their names.

Put the number 3 in front of the name of every person whom you consider to have high, but not exceptionally high standards of sportsmanship.

Put the number 2 in front of the name of every person whom you feel to be all right. These are people you feel would be pretty fair most of the time.

Put the number 1 in front of those people whom you know but you don't feel that their standards of sportsmanship are as high as the others.

Put the number 0 in front of the name of every person whom you don't know well enough to rate.

SECOND CRITERION INSTRUMENT

1. The other members of this class may be members of this hockey team. The team is behind when they get into position to score, and as one player drives the ball toward the goal, her teammate inadvertently lets the ball bounce off her foot into the goal. The umpire does not see the kicking foul and indicates the goal is good.

Which of your class members would be most likely to allow the umpire's decision to stand and accept the goal? Name in order.

Which of your class members would immediately indicate to the umpire that she fouled, thus disallowing the goal? In order.

2. Five of you are going on a weekend trip to your summer cottage. If you had a choice which four members of this class would you choose to go with you? List in order.

Which four would you be least likely to choose? List in order.

(Submitted 1/18/60)

Effects of Two Systems of Weight Training on Circulorespiratory Endurance and Related Physiological Factors

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Abstract

Three groups, two experimental and one control, consisting of 20 college freshmen in each group, were tested doing moderate and all-out exercise on a bicycle ergometer. Selected physiological responses and the circulorespiratory endurance times were measured. An eight-week training period followed during which the experimental groups participated in weight-training programs and the control subjects in archery or bait casting. After training, the tests were again administered.

Though there was an indication of improved circulorespiratory responses by the weight-training groups following training, statistical treatment of the data revealed no significant differences among the three groups in their responses to exercise.

RECENT RESEARCH STUDIES (3, 6, 13, 15) indicate that weight training is a sound physical activity in view of its effects on body structure and function. Today, due in some part to these research findings, weight training enjoys great popularity as a sports activity and as a method for conditioning athletes for diverse athletic pursuits. Yet, research evidence is neither complete nor clear-cut, especially that dealing with the effects of weight training on circulorespiratory endurance. Since this type of endurance is a desired outcome of most form of physical training, it is important that weight training be evaluated from this viewpoint.

The major problem of this research was to determine the effects of weight training on circulorespiratory endurance and on some of the physiological factors which are indicative of circulorespiratory efficiency. (Circulorespiratory endurance will be defined here as the ability to sustain prolonged activity in which circulorespiratory mechanisms are the primary limiting factors.)

A secondary problem was to determine the difference between two systems of weight training on the basis of their influence on circulorespiratory efficiency and endurance.

Review of the Literature

Wilson (14), using an all-out treadmill run as a measure of circulorespiratory endurance, found that a group of college students who trained with weights for a period of

12 weeks showed an average decrease in treadmill running time of 11.15 percent. A parallel group of control subjects who participated in volleyball classes following the initial test experienced a decrease in running time of 1.0 percent. Wilson concluded that weight training had a detrimental effect on circulorespiratory condition.

In a study conducted by Capen (3), the time of a 300-yd. run was used as a measure of circulorespiratory endurance. Capen found that a group that trained with weights improved in the 300-yd. run by 6.2 percent. The control group, with emphasis placed upon endurance elements in the training program, improved 6.3 percent. Capen concluded that weight training was as effective in the development of circulorespiratory endurance as was a program of activity which especially emphasized endurance.

Swegan (10) used an all-out run to exhaustion on a bicycle ergometer as a test of circulorespiratory endurance. He found that a group that trained with weights had increased its all-out pedaling time, thus indicating increased circulorespiratory endurance.

An element of conflict is apparent in the empirical arguments which deal with the subject. Steinhaus (9) has implied that weight training decreases circulorespiratory endurance because the increase in skeletal muscle bulk which occurs is not accompanied by a commensurate increase in the size and efficiency of certain circulorespiratory mechanisms. In effect, the increased skeletal muscle would place a greater load on the circulorespiratory system and ultimately decrease circulorespiratory endurance.

A different view is expressed by McCloy (7) when he points to muscle strength (which increases in proportion to size and is an undisputed outcome of weight training) as one of three factors necessary in the development of circulorespiratory endurance. An increase in strength, McCloy says, would necessitate fewer muscle fibers being used by an individual during a given bout of exercise. This being the case, the onset of fatigue in muscles should be delayed, thereby decreasing the demand on circulorespiratory mechanisms and prolonging the period over which physical activity could be continued.

Basic to the selection of specific weight training procedures is the principle established by DeLorme (4), who says that strength building exercises are those in which heavy resistance is used for a low number of repetitions. Endurance exercises are those in which low resistance is used for a large number of repetitions. Studies by Teufel (11), Walters (12), and Capen (2) have lent added credence to this principle. In Capen's research, in which he compared the effectiveness of four systems of weight training in developing strength, it was found that a one repetition—high resistance system was only 1.1 percent better in terms of mean strength gains than a system which employed 8 to 15 repetitions and low resistance.

This is an interesting finding, for if endurance as well as strength is desired in weight training, it is entirely possible that a high repetition system would prove more beneficial. It was the writer's purpose to test this hypothesis by comparing the effects of high and low repetition systems on circulorespiratory endurance.

Procedures

Sixty freshman students at the University of Florida, 18 to 19 years of age, voluntered to serve as subjects in this experiment. They were divided into three groups, equated on the basis of body surface area and 300-yd. run time which allowed for control of body size and endurance fitness.

All of the tests to which the subjects were submitted were completed during the early morning hours after the subjects had at least eight hours rest. All subjects reported for the tests in a postabsorptive state. They were allowed to rest for ten minutes in the laboratory before the testing began.

The tests were continued for seven minutes during which time the following resting measurements were made for control purposes:

1. Heart rate in beats per minute;
2. Respiratory rate in inspirations per minute;
3. Volume of respiration per minute in liters per square meter of body surface;
4. Oxygen consumption per minute in liters per square meter of body surface;
5. Carbon dioxide production per minute in liters per square meter of body surface;
6. Respiratory exchange ratio;
7. Volume of air inspired per inspiration in liters per square meter of body surface; and
8. Ventilatory efficiency (the ratio of oxygen consumed to the air inspired).

The heart rate was counted by using a stethoscope held over the heart at the chest wall. The respiratory rate was measured by counting the deflections of the needle of a dry test gas meter as it measured the volume of respiration. The oxygen consumption and carbon dioxide production were measured with a micro-Scholander gas analyzer using expired gas samples collected in Douglas bags. Duplicate analyses of samples were made to ensure the accuracy of the method. All the recorded determinations of gas volumes were corrected to standard conditions (760 mm., 0° centigrade, dry). The measurements of the respiratory ratio, depth of breathing, and ventilatory efficiency merely involved mathematical calculations with the data procured from the procedures explained above.

The next test procedure was concerned with measuring circulorespiratory responses during physical activity. This was done using a moderate exercise work load and an all-out exercise work load. The work was performed on a bicycle ergometer of the type described by Karpovich (5).

For the moderate exercise test the subjects pedaled at a rate of 4275 ft-lb of work per minute. A pilot study revealed that subjects working at this rate reached a "steady state" by the start of the third minute of exercise and that they were able to maintain this state for upwards of four minutes before the measurements of heart rate, respiratory rate, and the minute volume of respiration indicated another increase in metabolic activity. On the basis of this evidence the exercise was continued for seven minutes. Expired air samples were drawn from the third through the seventh minute for the determinations of oxygen consumption and carbon dioxide production.

Following a practice period in the use of a bicycle ergometer, the test was begun and the same measurements made at rest were again taken.

The endurance test was performed at the rate of 10,026 ft-lb of work per minute. In this test each subject was instructed to continue the exercise until told to stop by an attendant counting the heart rate. Throughout the test the attendant recorded the subject's rate for 15-sec. intervals during the second and fourth intervals of each minute. When the heart rate reached 168 beats per minute he began to count the rate in successive 15-sec. intervals until 45 beats per 15-sec. intervals, or 180 beats per minute, was reached. At this point the subject was stopped and the pedaling time recorded as the measure of his circulorespiratory endurance.

This technique for measuring circulorespiratory endurance was devised by Balke (1). In his work with Air Force cadets he found that respiratory incompetence and cardiovascular inadequacy became manifest when the pulse rate reached about 180 beats per minute during exercise. Balke says that this technique affords a measure of maximal performance by forcing the test to a point near exhaustion. However, the end point is established by physiological observation and measurement rather than the subject's will to cooperate. This technique obviously eliminates the subjectivity involved in an endurance test in which an individual supposedly continues exercise to the point of exhaustion. In a test-retest study of the reliability of the procedures all exercise measurements showed r's equal to .82 or higher.

Following the administration of the initial tests an eight-week training program was begun. The three groups, two experimental and one control, consisting of 20 subjects in each group, met three times per week on Mondays, Wednesdays, and Fridays. The training period on each of these days was one hour long. By the end of the eight-week period all subjects except those dropped from the study had completed 24 one-hour training periods with two groups participating in weight training and the control group participating in bait casting or archery, courses which require very limited physical activity.

One weight-training group used a system of low-repetition and high-resistance exercises (Group LH) while the other weight-training group used a system of high repetition—low resistance exercises (Group HL). Both groups used the same series of 13 exercises.

The exercises selected called into play all of the body's major muscle groups. These exercises, in which barbells were used, included the arm curl, military press, high pull-up, rowing, bench press, pull-over, dead lift, sit-up, squat, toe raise, straddle lift, two-hand repetition snatch, and an exercise in which a machine is employed to exercise the extensor muscles of the humerus. Throughout the training period Group LH performed two sets of each exercise for a maximum of five repetitions. Group HL performed two sets of each exercise with a maximum of 15 repetitions on the first set and 12 repetitions on the second set.

Following the training period the tests previously described were again administered. Four of the initial 60 subjects were dropped from the study during the training period. This left Group LH with 19 subjects, Group HL with 19 subjects and Group C, the control group, with 18 subjects.

Analysis of the Data

In Table 1 the mean scores on all measurements made during exercise for pre-training and post-training tests are reported.

Table 1 shows that Group LH had improved responses to exercise in heart rate, respiratory rate, minute volume of respiration, oxygen consumption, and volume per inspiration. This group also showed an improved response to the test of circulorespiratory endurance. A decreased economy of effort

TABLE 1.—MEAN SCORES OF GROUPS ON PRE-TRAINING AND POST-TRAINING EXERCISE MEASUREMENTS

Factor	Group	N	Means
Heart Rate (beats/min.)	LH_1-LH_2[a]	19	125.7-120.3
	HL_1-HL_2	19	127.5-122.3
	C_1- C_2	18	129.6-125.1
Respiratory Rate (ins./min.)	LH_1-LH_2	19	21.3- 18.4
	HL_1-HL_2	19	16.9- 16.0
	C_1- C_2	18	17.9- 17.2
Volume of Respiration (l./min./sq.m.)	LH_1-LH_2	19	12.98-12.91
	HL_1-HL_2	19	12.31-12.27
	C_1- C_2	18	12.54-12.81
CO_2 Production (l./min./sq.m.)	LH_1-LH_2	17	0.650-0.655
	HL_1-HL_2	17	0.666-0.658
	C_1- C_2	18	0.648-0.664
O_2 Consumption (l./min./sq.m.)	LH_1-LH_2	17	0.784-0.780
	HL_1-HL_2	17	0.781-0.766
	C_1- C_2	18	0.757-0.760
Respiratory Exchange Ratio	LH_1-LH_2	17	0.829-0.839
	HL_1-HL_2	17	0.852-0.858
	C_1- C_2	18	0.855-0.876
Volume/Inspiration (l./sq.m.)	LH_1-LH_2	19	0.672-0.744
	HL_1-HL_2	19	0.760-0.813
	C_1- C_2	18	0.729-0.782
Ventilatory Efficiency	LH_1-LH_2	17	0.055-0.055
	HL_1-HL_2	17	0.057-0.057
	C_1- C_2	18	0.055-0.055
Circulorespiratory Endurance (time in sec.)	LH_1-LH_2	17	168.3-213.1
	HL_1-HL_2	17	164.7-202.4
	C_1- C_2	16	170.9-170.8

[a] LH_1—Pretraining measurement.
LH_2—Post-training measurement.

is evident in the carbon dioxide production and the respiratory exchange ratio. No change appeared in ventilatory efficiency.

Group HL showed improved responses on all factors except the respiratory exchange ratio and ventilatory efficiency. On the former measurement a slight decrease in the economy of effort occurred and the latter measurement showed no change. Group C showed improved responses in heart rate, respiratory rate, oxygen consumption, and the volume per inspiration. A decreased economy of effort is evident in the minute volume of respiration, carbon dioxide production, respiratory exchange ratio, and in the test of circulorespiratory endurance. No change occurred in the ventilatory efficiency.

Table 2 presents the statistical comparisons made with the data. A three-way classification analysis of variance technique, described by McNemar (8),

was used. Time and groups comprised two classifications and subjects comprised the pseudo third classification. The differences in time (differences between pre-training and post-training measurements) indicate changes for all groups combined; differences among groups indicate differences in the combined pre-training and post-training measurements; the time by group interaction indicates differences among groups in the extent of change bebetween pre-training and post-training measurements.

The numbers of cases employed in the variance analyses were slightly less than those shown in Table 1. One case was randomly eliminated from a group wherever necessary for the purpose of equating the N's and simplifying the analyses and interpretation.

In making F determinations the residual term was used as the error term for testing time differences and for testing the interaction. The variance estimate for subjects was used as the denominator in the F ratios for testing group differences.

The heart rate data in Table 2 show that a significant F of 21.23 was obtained for the time variation. An F of 7.17 is required at the 1 percent level. For groups and the time by group interaction F's of 0.83 and 0.11

TABLE 2.—COMPARISONS OF EXERCISE MEASUREMENTS OF SELECTED PHYSIOLOGICAL RESPONSES AND CIRCULORESPIRATORY ENDURANCE

Factor	Source of Variation	Sum of Squares	df	Mean Squares	F
Heart Rate (beats/min.)	Subjects	11,730.60	51	230.01	
	Time	738.42	1	738.42	21.23
	Groups	380.54	2	190.27	0.83
	Time x Group	7.42	2	3.71	0.11
	Residual	1,774.17	51	34.79	
	Total	14,631.15	107		
Respiratory Rate (ins./min.)	Subjects	3,167.47	51	62.11	
	Time	61.53	1	61.53	13.70
	Groups	186.38	2	93.19	1.50
	Time x Group	27.74	2	13.87	3.09
	Residual	229.05	51	4.49	
	Total	3,672.17	107		
Volume of Respiration (l./min./sq.m)	Subjects	272.55	51	5.34	
	Time	0.08	1	0.08	0.21
	Groups	9.20	2	4.60	0.86
	Time x Group	0.86	2	0.43	1.13
	Residual	19.51	51	0.38	
	Total	302.20	107		
CO_2 Production (l./min./sq.m)	Subjects	0.4825	48	0.0101	
	Time	0.0002	1	0.0002	0.20
	Groups	0.0011	2	0.0006	0.06
	Time x Group	0.0038	2	0.0019	1.90
	Residual	0.0457	48	0.0010	
	Total	0.5333	101		

TABLE 2. (Continued)

Factor	Source of Variation	Sum of Squares	df	Mean Squares	F
O_2 Consumption (l./min./sq.m)	Subjects	0.1996	48	0.0042	
	Time	0.0001	1	0.0001	0.08
	Groups	0.0093	2	0.0047	1.12
	Time x Group	0.0025	2	0.0013	1.08
	Residual	0.0601	48	0.0012	
	Total	0.2716	101		
Respiratory Exchange Ratio	Subjects	0.2696	48	0.0056	
	Time	0.0002	1	0.0002	0.15
	Groups	0.0165	2	0.0083	1.48
	Time x Group	0.0033	2	0.0017	1.31
	Residual	0.0621	48	0.0013	
	Total	0.3517	101		
Volume/Inspiration (l./sq.m.)	Subjects	2.9892	51	0.0586	
	Time	0.0877	1	0.0877	13.09
	Groups	0.0619	2	0.0310	0.53
	Time x Group	0.0015	2	0.0008	0.12
	Residual	0.3396	51	0.0067	
	Total	3.4799	107		
Ventilatory Efficiency	Subjects	0.3593	48	0.0075	
	Time	0.0002	1	0.0002	0.17
	Groups	0.0319	2	0.0160	2.13
	Time x Group	0.0010	2	0.0005	
	Residual	0.0603	48	0.0012	0.42
	Total	0.4527	101		
Circulorespiratory Endurance (time in sec.)	Subjects	557,273.31	45	12,383.85	
	Time	16,016.67	1	16,016.67	11.04
	Groups	4,904.69	2	2,452.34	0.20
	Time x Group	8,182.27	2	4,091.14	2.82
	Residual	65,670.00	45	1,450.96	
	Total	642,046.84			

were obtained. These are not significant. For the respiratory rate the F for time is 13.70. This is significant beyond the 1 percent level. The F's for groups and the time by groups interaction were 1.50 and 3.09, respectively, neither of which is significant. The time by group interaction F is just below significance at the 5 percent level, an F of 3.18 being required. The minute volume of respiration yielded F's of 0.21 for time, 0.86 for groups, and 1.13 for the time by groups interaction. These values are not significant. None of the F's obtained for the carbon dioxide production, the oxygen consumption, or the respiratory exchange ratio is significant.

For the volume per inspiration a significant F was obtained for time as the source of variation. This F of 13.09 is significant beyond the 1 percent level since an F of 7.17 is required at this level. For the ventilatory efficiency the F's of 0.17 for time, 2.13 for groups, and 0.42 for the time by group interaction are not significant.

On the circulorespiratory endurance test the time variation yielded an F of 11.04. An F of 5.11 is required for significance at the 1 percent level. For groups the F of 0.20 is not significant. The F of 2.82 for the time by group interaction is also not significant, an F of 3.20 being required at the 5 percent level.

Interpretation of the Data

Table 2 shows that no significant changes occurred for any of the sources of variation for the measurements of the minute volume of respiration, carbon dioxide production, oxygen consumption, respiratory exchange ratio, and ventilatory efficiency. Significant changes did occur between times, for the heart rate, respiratory rate, volume per inspiration, and for circulorespiratory endurance for the combined groups. However, this cannot be attributed to weight training as is evidenced by the F's for the time by group interaction component for these same measurements. It will be recalled that the interaction component indicates differences among groups in the extent of change between pre-training and post-training measurements. The fact that none of these time by group interaction F's is significant indicates that the training of the different groups had no significant differential effect upon the moderate exercise physiological responses or circulorespiratory endurance.

It should be noted that the time by group interaction F's for respiratory rate and the circulorespiratory endurance test, of 3.09 and 2.82, respectively, are close to significance at the 5 percent level. It is possible that these F's represent an actual training effect. However, these results are, at best, inconclusive and must be checked further before the acceptance of the null hypothesis can be opened to question.

Conclusions

Despite some indication of weight training effects, it must be concluded that weight training has no significant effects on certain physiological responses to exercise or on circulorespiratory endurance to which these responses are related. This conclusion holds for weight-training systems utilizing five to fifteen repetitions per set.

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The Identification of the School Health and Safety Concerns of the Secondary School Physical Educator

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Abstract

The purpose of this study was to identify the health and safety concerns of the secondary school physical educator. A list of 137 possible health and safety concerns was compiled. These were secured from the professional literature, through interviews with experts in the field, and through introspection. This list was submitted to a jury of experts in physical education and health education to determine the relative importance of these concerns in contributing to the success of the physical education program. Fifty-one percent of the judges found that 83 of the statements represented health and safety concerns that were essential to the fulfillment of the objectives of secondary school physical education.

IN THE UNITED STATES the histories of physical education and health education are closely related. Van Dalen and others (17) state that in the 1830's it was believed that the primary purpose of physical education was to impart knowledge about the body, its organs and functions and that as late as the 1920's education in health matters was held to be the dominant aim of physical education.

Since the 1930's a concerted effort has been made to establish health education as a separate course offering in the schools (2). This effort has met with considerable success, and throughout the nation today we have increasing recognition of health education as a curriculum offering separate from physical education.

As in any area of endeavor where greater specialization or departmentalization has occurred, a problem relating to a division of responsibilities has arisen. This problem is more the concern of physical educators than health educators; obviously all health topics fall within the scope of health education, but what is not so clear is the identification of the health content that properly falls within the scope of physical education.

On the basis of the statements of certain authorities who treat this question it seems that health education is important to the integrity of physical education. Turner (16) has stated that one of the general objectives of physical education is to develop proper health habits, attitudes, and ideals toward healthful living. Moulton (11) speaks of the necessity of including a considerable amount of the material which belongs in the field of health education when planning for physical education. Richardson (14), in a study of the health education needs of physical educators, cites health as an inseparable part of physical education and one which touches upon every part of the physical education program. Rugen (15), who has studied this problem closely, lists six contributions that physical education has to make to health education. These are:

1. the physiological effects of exercise and their contribution to physical health;
2. the psychological effects of games, dance, and other physical activities, and their contribution to mental and emotional health and the development of sound social relationships;
3. the opportuniites in physical education activities for helping the individual to gain an understanding of certain physiological processes, anatomical structures, and mechanics of his body (physical education as a possible laboratory activity for the study of bodily movement, posture, etc.);
4. the opportunity to develop neuromuscular coordinations which have safety and utilitarian values as well as recreative and developmental ones;
5. the opportunity to apply principles of healthful living as they pertain to the creation of a wholesome and sanitary environment and as they are related to the personal health practices of the individual; and
6. the provision of incentives for healthful living and the establishment of sound health practices.

Knapp and Hagman (8) say that physical education has primary responsibility for instruction in health matters most directly related to physical activities.

Despite these conceptions of the role of health education in physical education, current practice in physical education seems to be leading more and more to the outright divorce of physical education from health education, though a dwindling group remains on the scene professing that physical education and health education are synonymous. There seems to be no common ground between these two schools of thought, one holding that physical education and health education are synonymous and the other maintaining that physical education and health education are, and should be, completely unrelated fields of study. That no common ground appears stems from the fact that we have not been articulate in defining it. We have not looked critically beyond the generalities to the specifics of the relationships between physical education and health education.

In the interest of educational efficiency it is imperative that the responsibilities of the physical educator for health education be clearly delineated. It will be only through such means that critical and pressing questions, such as "What health background should the physical educator have?" will be answered. Noteworthy to the discussion is the fact that the Research Council (13) of the American Association for Health, Physical Education, and Recreation has cited the need for research in this area.

Purpose of the Study

The purpose of this study was to identify in order of importance the school health and safety concerns of the secondary school (grades 9 through 12) physical educator. A working definition of school health and safety is those school procedures that contribute to the maintenance and improvement of the health of pupils and school personnel, including health services, health instruction, and healthful school living.

Procedure

Phase One. The first phase was devoted to a study of the professional literature in order to obtain a list of possible health and safety concerns of the secondary school physical educator. This phase consisted of four subproblems.

1. Determination of possible concerns through the examination of textbooks in the field of physical education.
   a. Four textbooks in principles and/or philosophy of physical education (4, 6, 12, 19).
   b. Three textbooks in administration and organization of physical education (1, 3, 18).
   c. Three textbooks in methods in physical education (8, 9, 10).
   d. Two textbooks in curriculum in physical education (5, 7).

2. Determination of possible concerns through the examination of periodical literature in physical education.
   a. RESEARCH QUARTERLY (1936-1956).
   b. *Journal of Health, Physical Education, Recreation* (1936-1956).
3. Determination of possible concerns through interviews with authorities in the field of physical education.
4. Determination of possible concerns through introspection.

Statements were selected from these sources on the basis of their fulfilling the following criteria:

1. The statement suggests an action which has direct implications for school health and safety.
2. The statement suggests an action which may be a concern of the physical educator in achieving the objectives of the secondary school physical education program.

Phase Two. The next consideration was that of identifying the health and safety concerns of the secondary school physical educator and the relative importance of these concerns in contributing to the success of the physical education program. This involved submitting a refined list of possible concerns to a selected group of national leaders in health and physical education.

The group of national leaders rating the items consisted of 15 prominent university professors of physical education, 10 prominent university professors of health education, and 10 prominent secondary school supervisors of physical education.[1]

The university professors were selected on the basis of their contributions to their respective professions as evidenced by numerous publications and service on national committees in health and physical education. The secondary school physical education supervisors were selected on the recommendations of their state directors of physical education. The group represents all areas of the United States.

These leaders were asked to judge each item on consideration of the following questions:

1. Does this item suggest an action which should be a concern of the physical educator in achieving the objectives of the secondary school physical education program? On this basis the item was to be judged "Not a Concern" or "A Concern."
2. If the item constitutes "A Concern" of the physical educator, of what importance is this concern in achieving the objectives of the secondary school physical education program?

In rating the items five categories were used and the judges were asked to place a check in the appropriate column beside each item. The various categories were:

1. Not a concern of the physical educator.
2. A concern which makes a minor contribution to the objectives of the secondary school physical education program. (Category designated as Some Importance, "S. I.")
3. A concern which makes more than a minor but not a major contribution to the achievement of the objectives of the secondary school physical education program. (Category designated as Moderate Importance, "M. I.")
4. A concern which makes a major contribution but is not necessarily essential for

[1] The large number of national leaders who contributed to this study precluded the listing of their names. The writer is indebted to them for their assistance.

the achievement of the objectives of the secondary school physical education program. (Category designated as Considerable Importance, "C. I.")

5. A concern which makes a major contribution and is essential for the achievement of the objectives of the secondary school physical education program. (Category designated as Extreme Importance, "E. I.")

A small number of the items involved a time factor. If the judge did not find the time factor included in the statements acceptable to him he was instructed to change it to suit his thinking in the matter before rating the statements. The time factors which appear in the Appendix are those which appeared in a majority of the responses.

Thirty-three of the 35 original judges participated in the study, but the responses of five were eliminated since it was obvious that instructions for completing the instrument had not been followed correctly. Percentage ratings were thus calculated from the data secured from 28 judges. The percentage of the total number of experts rating each item of extreme importance was the technique used in arriving at a rank order of importance of the items.

To facilitate the organization and the rating of the items, they are categorized and listed in order of importance under the headings "Health Instruction," "Health Services," and "Healthful School Living."

The split-half method was used to determine the reliability of the evaluative instrument submitted to the jury of experts. The completed instruments were divided into two sets arbitrarily. The treated data revealed an r of .82 between the two sets of instruments.

One hundred and thirty-seven statements were selected from all possible sources for fulfilling the following criteria:

1. The statement suggests an action which has direct implications for school health and safety.
2. The statement suggests an action which may be a concern of the physical educator in achieving the objectives of the secondary school physical education program.

Results

Eighty-three statements were rated as being extremely important to the fulfillment of the objectives of physical education by 51 percent, or a majority, of the judges. Fifty-four statements were rated as nonessential to the fulfillment of the objectives of physical education by 50 percent of the judges.

Detailed findings of the study are presented in the appendix.

On the basis of the reported data one can justifiably conclude that the secondary school physical education program has considerable health and safety content with which the physical educator must be concerned in attempting to achieve the objectives of the physical education program.

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Appendix

THE RANK ORDER OF IMPORTANCE OF THE HEALTH EDUCATION CONCERNS OF THE SECONDARY SCHOOL PHYSICAL EDUCATOR

Health Instruction

The Physical Educator:	Not a Concern %	A Concern %			
		S.I.	M.I.	C.I.	E.I.
1. Frequently supervises locker and shower rooms for the purpose of observing health and safety practices of students and of providing health and safety instruction where needed.	0	4	0	11	85
2. Provides formal group instruction to students on safety procedures in the use of the swimming pool in physical education classes.[a]	0	9	7	11	79

[a] Formal group instruction is defined as planned, detailed instruction taking place in the classroom, gymnasium, or playing field setting.

The Physical Eductor:	Not a Concern %	A Concern %			
		S.I.	M.I.	C.I.	E.I.
3. Provides instruction and activities to develop and maintain physical fitness of students in physical education classes.	0	0	3	25	72
4. Provides formal group instruction to students on the safety procedures in the use of physical education facilities in physical education classes.	0	7	4	22	67
5. Provides formal group instruction to students on rest and fatigue as it relates to physical education activities.	7	0	11	21	61
6. Integrates physical education class activities and health education class activities where it is possible and advantageous to do so.	0	3	0	36	61
7. Provides formal group instruction to students on safety procedures peculiar to the activities being taught in physical education classes.	0	7	12	22	59
8. Provides formal group instruction to students on accident and injury procedures to be followed in physical education classes.	8	16	8	12	56
9. Provides bulletin board materials on safety rules and regulations to be observed by students in the physical education programs.	0	3	7	36	54
10. Provides formal group instruction to students on personal hygienic procedures peculiar to the use of the swimming pool in physical education classes.	0	7	7	32	54
11. Provides formal group instruction to students on personal hygienic procedures which include showering, drying, and grooming in physical education classes.	3	7	11	29	50
12. Provides formal group instruction to students on sanitary procedures in the use of swimming pool, gymnasium, locker, and shower room facilities in physical education classes.	0	7	4	39	50
13. Provides instruction for students in physical education classes in water safety.	0	0	3	47	50
14. Provides formal group instruction to students on the sociological value of physical education activities.	11	7	11	25	46
15. Provides formal group instruction to students in basic first aid in physical education classes.	21	11	14	8	46
16. Establishes and instructs students in interscholastic athletics in training procedures to be followed during sports seasons.	0	0	8	46	46
17. Provides bulletin board materials emphasizing the relationship of health to physical education program activities.	0	14	21	19	46
18. Provides incidental group and/or individual instruction to students on the sociological value of physical education activities.	0	10	18	29	43
19. Provides instruction and activities for students to develop and maintain acceptable posture habits in physical education classes.	3	14	25	15	43
20. Provides instruction and activities in body mechanics to students in physical education classes.	0	14	14	29	43
21. Provides instruction and activities in techniques of muscle relaxation to students in physical education classes.	0	7	18	32	43
22. Provides instruction for students in physical education classes in life saving.	0	0	7	50	43
23. Provides formal group instruction to students on the cause and prevention of disease encountered in the use of facilities and equipment in physical education classes (example: fungus infections).	7	11	15	26	41
24. Places emphasis in physical education classes on skills having safety value such as dodging, jumping, falling, and climbing.	7	7	7	38	41

The Physical Educator:	Not a Concern %	A Concern %			
		S.I.	M.I.	C.I.	E.I.
25. Includes appraisal of health and safety learning in knowledge tests administered to students in physical education classes.	0	7	21	33	39
26. Uses rating scales, check lists, and other evaluative devices to appraise the health and safety practices of students in physical education classes.	3	14	22	22	39
27. Provides formal group instruction to students in nutrition as it relates to physical education activities.	19	8	12	23	38
28. Provides incidental group and/or individual instruction in basic first aid to students in interscholastic athletics.	23	12	4	23	38
29. Provides formal group instruction to students on physical culture and physical training fads and fallacies.	11	29	14	14	32
30. Considers health and safety practices of students in grading in physical education classes.	0	14	14	40	32
31. Provides formal group instruction to students in muscle physiology as it relates to physical education activities.	21	3	29	18	29
32. Provides formal group instruction to students on the function of physical activity as an aid or deterrent to convalescence following illness.	18	14	7	32	29
33. Provides formal group instruction to students in respiratory physiology as it relates to physical education activities.	21	8	25	25	21
34. Provides formal group instruction to students in digestive physiology as it relates to physical education activities.	21	11	18	29	21
35. Provides formal group instruction to students in circulatory physiology as it relates to physical education activities.	18	11	21	32	18
36. Provides formal group instruction to students in body metabolism as it relates to physical education activities.	25	7	29	21	18
37. Considers health and safety practices of students in making awards in interscholastic athletics.	21	18	15	32	14
38. Considers health and safety practices of students in making awards in intramural sports.	14	21	18	36	11
HEALTH SERVICES					
1. Refers students needing medical attention to school health service authorities.	0	0	0	4	96
2. Makes the final assignment of students to the corrective physical education program on the basis of a physician's recommendation.	0	0	7	4	89
3. Provides for a limited or modified program of physical education.	3	0	4	22	71
4. Makes the final assignment of students to the limited or modified program of physical education on the basis of a physician's recommendations.	0	0	14	15	71
5. Is qualified and administers first aid when needed in the physical education program.	0	3	12	14	71
6. Makes daily accident and injury reports to school health service authorities.	0	4	8	17	71
7. Personally conducts the corrective physical education program under the direction of a physician.	0	7	7	15	71
8. Keeps written reports on all accidents and injuries that occur in the physical education program.	0	0	4	26	70
9. Provides for a corrective program of physical education under medical supervision.	4	4	7	22	63
10. Counsels with students regarding results of physical education tests and measurements concerned with such items as growth patterns, posture, body mechanics, and physical fitness.	0	0	21	18	61

The Physical Educator:	Not a Concern %	A Concern %			
		S.I.	M.I.	C.I.	E.I.
11. Determines physical fitness status of students in physical education classes.	0	3	11	29	57
12. Personally conducts the limited or modified physical education program under the direction of a physician.	0	7	15	22	56
13. Serves on the school health and safety council.	0	7	21	18	54
14. Counsels with students enrolled in physical education classes on their special personal health problems.	3	0	22	25	50
15. Interprets to students features of their school health records which have implications for their physical education activities.	3	3	29	26	39
16. Maintains physical education records on each student to include such items as measures of posture, body mechanics, physical fitness, health, and anthropometric measures.	4	19	4	36	37
17. Supplements school health record information with results of tests and measurements found in physical education classes.	7	4	30	22	37
18. Determines posture status of students in physical education classes.	7	11	29	21	32
19. Determines body mechanics status of students in physical education classes.	0	7	25	36	32
20. Periodically appraises growth and development patterns of students in physical education classes through testing and measuring devices.	3	7	18	43	29
21. Is qualified and treats minor injuries to students in the physical education program (example: skin abrasions, blisters, minor sprains).	20	8	20	24	28
22. Personally assists physician with health examinations of students.	15	26	15	18	26
23. Performs a physical inspection of individual students in physical education classes.	7	21	22	29	21
24. Is qualified and performs massaging, bandaging, and taping duties in the physical education program.	19	15	22	25	19
25. Provides and directs a physical education safety committee.	3	21	36	21	19
26. Keeps a log or anecdotal record of unique occurrences in the daily observation of the behavior of students in physical education classes.	0	36	21	24	19
Healthful School Living					
1. Provides for constant and qualified supervision of the swimming pool when it is in use for physical education activities.	0	0	0	0	100
2. Provides adequate training and conditioning for any demanding physical performances expected of students in physical education classes.	0	0	0	7	93
3. Provides for limitations on the number of events students may participate in during an athletic meet or match in accordance with standards set by state high school athletic associations and/or the N.F.S.H.S.A.A.[b]	3	0	0	4	93
4. Provides for limitations on the number of interscholastic athletic games that may be played in any one week in accordance with standards set by state high school athletic associations and/or the N.F.S.H.S.A.A.	3	0	0	4	93
5. Prohibits such practices as the use of a single drinking cup and single towel for use of students in the physical education program.	0	0	3	4	93
6. Provides for qualified supervision for all activities organized and conducted in the physical education program.	0	0	3	4	93

[b] National Federation of State High School Athletic Associations.

The Physical Educator:	Not a Concern %	A Concern %			
		S.I.	M.I.	C.I.	E.I.
7. Reports unsafe and/or unsanitary conditions of physical education facilities (including swimming pool) to proper authorities.	0	0	0	7	93
8. Has established emergency procedures to follow in event of illness or injury to students in the physical education program.	0	0	0	11	89
9. Cooperates closely with school health authorities regarding medical excuses from physical education for students temporarily below par.	0	0	3	8	89
10. Provides for limitations on the number of interscholastic athletic games scheduled in various sports seasons in accordance with standards set by state high school athletic associations and/or the N.F.S.H.S.A.A.	3	0	0	8	89
11. Investigates causes of all accidents in the physical education program.	0	0	4	7	89
12. Requires the use of safety devices for students where the occasion demands it in the physical education program.	0	0	3	8	89
13. Provides for inspection of swimming pool daily to determine such factors as water temperature, bacterial content, chlorine content, and the ph.	0	0	0	11	89
14. Requires special health examination for students participating in interscholastic athletics before each sports season.	7	0	4	3	86
15. Arranges play areas to minimize physical hazards.	0	0	3	11	86
16. Organizes practice schedules in interscholastic athletics to require progressively increased physical effort by participants until adequate physical conditioning is attained.	3	0	0	14	83
17. Provides a preseason training and conditioning period for students in interscholastic athletics in accordance with standards set by state high school athletic associations and/or the N.F.S.H.S.A.A.	7	0	0	11	82
18. Makes a special health observation of students for such factors as cleanliness, skin disorders, and respiratory ailments before they enter the swimming pool in physical education classes.	0	0	3	15	82
19. Establishes ground rules for games and sports where necessary to provide protection in the physical education programs against special hazards to the safety of students.	0	0	0	18	82
20. Provides for the inspection of locker room, shower room, gymnasium, and swimming pool area daily for sanitary conditions.	0	4	4	10	82
21. Presents himself as an example of good health, physical fitness, and sound hygienic practices.	0	0	3	18	79
22. Develops and maintains healthful personal relationships with students in the physical education program.	0	0	7	14	79
23. Requires a hot soap shower bath for students before allowing them to enter the swimming pool in physical education program activities.	0	0	7	15	78
24. Selects activities for physical education classes with consideration of the health and safety factors involved.	0	0	7	25	78
25. Knows health status of students in physical education program as determined by the students' health examinations.	0	0	3	19	78
26. Provides for physician's services at interscholastic athletic contests where body contact is involved.	7	0	11	4	78
27. Maintains a close working relationship with those responsible for school health education.	0	0	3	22	75
28. Excuses students in the convalescent stage following illness or injury from the regular physical education activities or provides modified physical education activities for them.	0	3	3	19	75

The Physical Educator:	Not a Concern %	A Concern %			
		S.I.	M.I.	C.I.	E.I.
29. Provides and observes eligibility rules for students in interscholastic athletics at least as restrictive as those adopted by state high school athletic associations and/or the N.F.S.H.S.A.A.	7	0	0	18	75
30. Provides highest quality protective equipment, with emphasis on fit, for students in the physical education program.	0	0	3	22	75
31. Provides for inspection of equipment and supplies for interscholastic athletics before each sports season and during each season to see that they meet safety standards.	3	3	0	19	75
32. Provides for inspection of facilities for interscholastic athletics before each sports season and during each season to see that they meet safety standards.	3	3	3	16	75
33. Sees that adequate rescue equipment is provided in the swimming pool.	0	4	0	22	74
34. Sees that adequate first aid supplies and equipment are available in the gymnasium and wherever physical education program activities are held.	0	4	0	22	74
35. Provides for inspection of equipment and supplies presently in use in physical education classes weekly to see that they meet safety standards.	0	4	7	15	74
36. Provides physical education class activities in which the standards of performance are such that with reasonable effort all students may frequently experience success.	0	3	7	18	72
37. Requires the use of protective equipment for students where the occasion demands it in the physical education program.	3	0	4	23	70
38. Conducts activities in the physical education program to prevent excessive fatigue in students.	3	0	7	22	68
39. Provides for warm-up period prior to strenuous physical activity in the physical education program.	0	7	0	25	68
40. Provides for limitations on distance of trips taken by interscholastic athletic teams in accordance with standards set by state high school athletic associations and/or the N.F.S.H.A.A.	3	0	0	29	68
41. Requires a shower bath for each student after a vigorous physical education class activity period.	0	7	3	22	68
42. Limits practice sessions in interscholastic athletics to a maximum of two hours daily.	7	7	0	19	67
43. Insists on students using freshly laundered towels after shower baths taken after physical education program activities.	4	4	11	14	67
44. Has physician on call for all noncontact interscholasitc athletic contests and for athletic practice sessions in the physical education program.	3	7	18	8	64
45. Schedules interscholastic athletic activities on week day afternoons and/or Friday and Saturday evenings only.	4	7	11	15	63
46. Uses only officials certified by state high school athletic associations to officiate interscholastic athletic events.	4	4	11	18	63
47. Sees that indoor physical education facilities (including swimming pool) are properly ventilated.	0	4	7	26	63
48. Limits sizes of physical education classes for safety purposes.	0	0	12	26	62
49. Requires that students secure physician's permission before being allowed to participate in intramural sports after illness or injury requiring an extended absence from school.	7	3	11	18	61
50. Prohibits postseason contests in interscholastic athletics.	11	11	3	14	61
51. Sees that indoor physical education facilities (including swimming pool) are properly lighted when in use.	0	7	7	25	61

The Physical Educator:	Not a Concern %	A Concern %			
		S.I.	M.I.	C.I.	E.I.
52. Provides for inspection of physical education facilities bi-weekly to see that they meet safety standards.	4	4	9	22	61
53. Sees that the training room treatment and care services for students in the physical education program are under the direct supervision of a physician.	0	15	7	19	59
54. Provides for a 10- to 12-minute dressing and grooming period following physical education class activities.	0	4	4	33	59
55. Prohibits boxing as a physical education program activity.	11	8	4	20	57
56. Requires students to have health examinations before allowing them to participate in physical education classes.	8	8	4	24	56
57. Insists on freshly laundered uniforms for students in physical education classes each week.	4	7	15	18	56
58. Attempts to restrict competition in team games to teams of comparable ability in the physical education program.	0	3	0	43	54
59. Allows students in interscholastic athletics to participate in one sport only during a sports season.	7	3	0	36	54
60. Provides a preseason training and conditioning period for students in strenuous intramural sports.	13	13	4	18	52
61. Classifies students in physical education classes on basis of such criteria as age, size, health status, and skill.	3	3	7	40	47
62. Personally trains and conditions interscholastic athletic teams.	8	13	13	20	46
63. Confines interscholastic athletic competition to senior high school students.	25	22	4	4	45
64. Allows students in intramural sports to participate in one sport only during a sports season.	7	19	0	36	38
65. Classifies students in intramural sports on basis of such criteria as age, size, health status, and skill.	4	8	12	38	38
66. Limits participation of students in interscholastic athletics to two sports per year in separate sports seasons.	20	12	4	28	36
67. Requires that students absent from school for an extended period due to illness or injury secure a physician's permission before being allowed to participate in physical education classes.	4	12	27	22	35
68. Provides for a limited period of progressively reduced exercises for students following a strenuous interscholastic sports season in an attempt to reestablish equilibrium between exercise, diet, and rest.	11	7	7	42	33
69. Determines the sociometric patterns that exist among students and utilizes this information in conducting physical education classes.	0	21	11	36	32
70. Secures a daily weight check on students participating in strenuous interscholastic athletics.	7	18	18	25	32
71. Uses student leaders in physical education classes trained in physical education safety practices.	0	0	18	50	32
72. Insists on the use of a prescribed uniform for students in physical education classes.	6	15	19	30	30
73. Allows for a time interval between the lunch period and scheduled physical education activities.	17	13	21	28	21

(Submitted 3/7/60)

Effects of Food Supplement on the Performance of Selected Gross Motor Tests

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Abstract

The purpose of this investigation was to study the effect of a well-advertised vitamin-mineral supplement on three selected gross motor tests. Experimental and control groups were formed in two groups, football players and physical education majors. Measurements were taken at five different time periods covering a period of 12 weeks. No statistically significant differences in motor performance were found between those subjects taking the supplement and those taking the placebo.

THE PURPOSE OF this investigation was to study the effect of a well-advertised vitamin and mineral supplement on three selected gross motor physical fitness tests. The gross motor tests appear to contain some of the important basic components found in physical fitness and the ability to perform athletic types of activity.

Subjects

Subjects for the experiment were the Utah State University football team and a group of physical education majors, all active and in good physical condition. The football team was selected because the men participated in essentially the same activity program and ate their meals at the training table, which permitted all of them to consume the same diet during the first month of practice. (Most of the team members continued eating at the University cafeteria even after the first month.) The group similarities in activity and diet offered much more control to the experiment than is commonly found in a less homogeneous group.

Procedure

The football players and the nonfootball players were each subdivided into two groups in such a manner as to balance the weight of the respective groups. To illustrate, the football players were ranked according to weight, the heaviest two were allocated at random to the two groups, the next two heaviest were allocated at random to the two groups, and so forth down to the lightest two players. This way the total weight of the individuals in each group was approximately equal. The same procedure was repeated with the nonfootball players. Of the two groups of football players, one received supplement and the other received placebos. The same procedure was repeated

with the nonfootball players. The placebos were so constructed that the individuals had no knowledge of whether or not they were receiving supplement.

An unequal number of individuals in the four groups completed the test period. In order to simplify the analysis procedures, groups having larger than the minimum (11) were reduced to the minimum number by randomly discarding the desired number of individuals, some of whom had not completed all five tests. This procedure gave the final result of four groups of students of 11 each.

Measurements were taken on each individual at five different time periods: (a) before the experiment started, or zero weeks; (b) two weeks after the experiment had been started; and (c) four, (d) eight, and (e) twelve weeks after beginning the experiment. Tests were administered to all the same day and the same time of each day.

Tests

The gross motor tests were selected to test such basic components as speed and reaction time, power (vertical), and strength and endurance. These items are believed to be a part of athletic types of activity and the tests have indicated high precision on another study (1). The tests were given in the sequence listed so that the effects from one test to another would be uniform.

TEST ONE. STARTING AND RUNNING

An upright starting position was used with each subject running ten yards. The electric timing device was started by clapping two copper covered boards together. As the sheets of copper came together, the clock started and continued until the runner broke the electric circuit by striking a gate switch, waist high, across the finish line. Time was recorded to the nearest 1/100 second. Each subject's score included the average of five timed trials.

TEST TWO. VERTICAL JUMP

The subject reached as far as possible with heels kept on the floor and made a chalk mark on the wall. He next executed three jumps from a crouched position, making a finger imprint each time on the wall board. The distance from the top of the reach mark to the top of each jump mark was measured. The average of three jumps was used as the score.

TEST THREE. BICYCLE ERGOMETER

Maximum revolutions in 60 seconds against a ten-pound resistance was used as the score.

Results[1]

The averages for each of the four groups of 11 subjects for the five time periods and three types of measurement data are presented in Table 1. It was observed that there were differences in the initial measurements for the four groups in each of the types of data. Since the treatments had not been applied at this time, these differences must be attributed to actual differences in the subjects themselves. It appears that the performance of individuals is

[1] Statistics on this project were completed in the Utah State University Statistical Laboratory under the direction of Rex Hurst.

TABLE 1.—MEANS OF FOOTBALL TEAM AND PHYSICAL EDUCATION MAJORS USING FOOD SUPPLEMENT AND PLACEBOS THROUGH THE FIVE TESTING PERIODS

	Initial Test	Test 2	Test 3	Test 4	Test 5
Ergometer (Revolutions)					
Football Team:					
Supplement	290.2	310.3	316.1	324.1	332.3
Placebos	281.4	297.5	302.7	320.0	322.8
Phys. Ed. Majors:					
Supplement	267.0	281.3	296.5	306.1	308.3
Placebos	259.8	276.6	288.7	294.4	292.6
Speed and Reaction (Seconds)					
Football Team:					
Supplement	2.204	2.213	2.188	2.172	2.159
Placebos	2.238	2.283	2.231	2.192	2.213
Phys. Ed. Majors:					
Supplement	2.239	2.211	2.172	2.149	2.128
Placebos	2.292	2.257	2.220	2.235	2.220
Vertical Jump (Inches)					
Football Team:					
Supplement	21.846	19.712	20.933	21.096	21.576
Placebos	20.585	19.334	19.425	20.636	21.227
Phys. Ed. Majors					
Supplement	21.592	21.438	22.205	22.227	22.614
Placebos	20.185	20.196	20.810	20.787	21.196

not very well determined by their weight and adjusting groups to equal initial weight conditions is not a satisfactory criteria. In this experiment the differences observed in the initial measurements were consistently in favor of the supplement groups. In view of this, it was decided that the subsequent measurements should be adjusted for initial performance. This was done, using covariance techniques.

The analysis was designed to identify two error terms, one appropriate for the correlated data, and one for the noncorrelated data. The analysis for all variables identified the variances as shown in Table 2.

The variances for supplement x type were not significant. The variances for periods were significant at the .005 level for all variables, indicating that learning or conditioning occurred during the experiment for all groups of subjects. With reference to the effect of the supplement as compared with the placebo, the differences noted were too small to be of biological significance and they were not found to be statistically significant for any of the three motor tests.

Summary and Discussion

The minimum daily requirements for most nutrients have been determined, yet there are many widely advertised food supplements that claim

TABLE 2.—ANALYSIS OF VARIANCE AND COVARIANCE FOR THE ERGOMETER, SPEED AND REACTION, AND VERTICAL JUMP

Source		Ergometer	Speed and Reaction	Vertical Jump
	Adjusted Data d.f.	*Adjusted Mean Square*	*Adjusted Mean Square*	*Adjusted Mean Square*
Supplement	1	1,265.65 (.10)	.029624 (.10)	1.414268
Type of Student	1	3,476.29 (.10)	.058875 (.025)	57.289654 (.005)
Supplement x Type	1	9.68	.000874	4.088832
Error (a)	39	371.21	.009669	4.224927
	Raw Data d.f.	*Mean Square*	*Mean Square*	*Mean Square*
Periods	3	4,659.72 (.005)	0.32564 (.005)	17.158674 (.005)
Period x Supplement	3	46.97	.001453	.930384
Period x Type	3	220.23 (.05)	.001525	2.042308 (.05)
Period x Supplement x Type	3	178.02	.004203	.824800
Error (b)	120	76.97	.001965	.743300

favorable contribution to the human body regardless of whether a person has a balanced diet or not. The claims range all the way from feeling better to the curing of certain diseases. Athletes and coaches have been a prize target because the claims of some food supplement companies have included improvement in sports' performance. Very little information has come from scientifically controlled conditions.

This study utilized athletes with essentially the same kind and amount of activity and a similar balanced diet. Consequently, the conditions, which appear to influence sports performance most were fairly well controlled. The gross motor tests were selected to test the basic components of speed and reaction time, power, strength, and endurance, which are believed to be a major part of athletic types of activity.

Results of the experiment indicated differences that were not found to be statistically significant, and hence could not be of biological significance in human sports performance. It must, therefore, be concluded that the vitamin and mineral supplement had no significant effect on the athlete's ability to perform the gross motor tests used in the study. The most important contribution to improvement in athletics would seem to come from the coaching and work accomplished on the athletic field.

Reference

1. Nelson, Dale O. "Effects of Ethyl Alcohol on the Performance of Selected Gross Motor Tests." *Research Quarterly* 30: 312-32; October 1959.

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Health Education Needs of High School Students in a Large Diversified Metropolitan Area

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Abstract

In addition to the findings of related studies, four sources of information were selected as a basis for determining the health education needs of high school students. Data were obtained from a representative sample of 959 B10 and A12 grade students in eight Los Angeles high schools by use of the *LeMaistre Health Behavior Inventory*, the *Mooney Problem Check List*, information derived from appraisals by school physicians' examinations, and personal data questionnaires on health history which students were asked to complete. The *LeMaistre Inventory* showed greatest weaknesses to be in the health education areas of sleep, rest, and relaxation; prevention and control of chronic and degenerative diseases; safety education; and consumer health. The *Mooney Check List* showed most student concerns to be in the areas of sleep, rest, and relaxation; mental health; personal health; and nutrition. From the physicians' examinations, orthopedic, dental, visual, and skin defects were observed most frequently; these findings have implications for the instructional areas of personal health and dental health. From student personal health histories, nutrition; consumer health; sleep, rest, and relaxation; and stimulants and depressants were evident as the instructional areas needing greatest emphasis.

Although little or no statistically significant relationship was found among students' scores on the various techniques which were used to identify needs, it was possible to note an interrelationship among the rank order of certain areas. Moreover, statistically significant grade and sex differences (.05) were apparent in certain aspects of students' health behavior.

PUBLIC RECOGNITION of the importance of health to national security and to the nation's future role in the various fields of human endeavor has results in school-community programs aimed at the promotional as well as the preventive and rehabilitative aspects of health. Health education may be thought of as the process of providing learning experiences for the purpose of promoting effective living as it is directed toward bringing about desirable changes in the health behavior of individuals.

Identifying the health education needs of students and utilizing the findings as guideposts for curriculum planning provides a meaningful and realistic foundation for school health education and gives purpose and direction to its activities. Therefore, the investigation of needs was conducted to provide information which may be of value in the further development of high school programs in this subject field and in the justification or improvement of pres-

[1] This study was made in partial fulfillment of requirements for the Doctor of Education degree at the University of California at Los Angeles in 1959.

ent practices. Specifically, the questions to be answered by this study were:

1. What are the health education needs of high school students in the Los Angeles area?
2. What is the extent of their health knowledge, attitudes, and practices?
3. What frequency, variety, and intensity of health problems do these students report?
4. What is the health status of these students as appraised by the school physician and students' health histories?
5. Is there a relationship between the general level of students' health education behavior and their grade level and sex?
6. Is there a relationship between the number of health problems students report and their grade level and sex?
7. Is there a relationship among the scores on the *LeMaistre Health Behavior Inventory*, the number of problems student report, and their health status?

Methods

Evidence of students' knowledge, practices, concerns, and physical status was considered essential as a basis for a study which seeks to identify health education needs. Consequently, in addition to the findings of related studies, four sources of information were selected as basic to this investigation. The data were obtained from a representative sample of 959 tenth and twelfth grade students in eight Los Angeles High Schools by means of a health knowledge-attitude-practice inventory, a problem check list, a personal history questionnaire, and the school physicians' appraisals of students' health status.

It was feasible to classify the health education needs of students into the 13 informational categories which are commonly used in planning the scope of health instruction. The areas were: personal health; nutrition; sleep, rest, and relaxation; mental health; prevention and control of chronic and degenerative disease; physical activity and recreation; consumer health; community health; dental health; family health; stimulants and depressants; and safety education.

Results are summarized into health education areas indicating specific weaknesses, defects, and problems of students. Rank order classification is utilized to determine the areas of greatest weakness and of most concern to students. Means, range of scores, standard deviations, and significance of the differences between groups are computed from the results of the *LeMaistre Health Behavior Inventory* (1) and the *Mooney Problem Check List* (2, 3). Coefficients of correlation are computed in order to test the hypotheses of relationships existing among the variables of the study.

Findings

The *LeMaistre Health Behavior Inventory* was employed to determine the nature and extent of students' health education behavior. The instrument

consists of 50 multiple-choice problem situations designed specifically to test understanding and to hypothetically appraise health attitudes and behavior of high school age groups in search of 13 areas of health education. Analysis of responses and group scores showed that:

1. Greatest weaknesses were apparent in students' responses to items in the areas of sleep, rest, and relaxation; prevention and control of chronic and degenerative disease; safety education; and consumer health. For these areas, less than 62 percent of the responses were correct.

2. A statistically significant difference was found between the health behavior scores of tenth and twelfth grade students (.05).

3. A significant difference was evident between the health behavior scores of boys and girls (.05).

4. In comparison with established percentile norms for the *LeMaistre Health Behavior Inventory* both groups fell below the level of achievement for their respective grades.

Table 1 lists the number of B10 and A12 participants, their mean scores and standard deviations, and the significance of the difference between means. The A12 group achieved higher mean scores and showed greater spread or variance of scores than the B10 group.

Table 2 lists the number of male and female participants, their mean scores and standard deviations, and the significance of the difference between the means. The male group achieved lower mean scores and showed greater variance of scores than the female group.

Girls achieved the highest mean scores and showed the smallest variance or spread of scores among the four groups. The range of scores for the 50 items was from 0 through 47 for B10's and from 0 through 49 for A12's.

TABLE 1.—A COMPARISON OF SCORES ON THE LEMAISTRE INVENTORY FOR B10 AND A12 STUDENTS

	No. of Students	Mean	S.D.	t	S.E. Diff.
B10	488	34.37	7.39		
A12	471	36.11	8.31	3.41[a]	.5090
Total	959	35.22	7.70		

[a] Significant at 5 percent level of confidence.

TABLE 2.—A COMPARISON OF SCORES ON THE LEMAISTRE INVENTORY FOR MALE AND FEMALE STUDENTS

	No. of Students	Mean	S.D.	t	S.E. Diff.
Male	487	33.74	8.40		
Female	472	36.75	7.04	6.00[a]	.5005

[a] Significant at 5 percent level of confidence.

A modified form of the *Mooney Problem Check List* was employed in an attempt to determine the number and kinds of health problems students report as troublesome. The instrument consists of 92 items through which students may give expression to the range and diversity of their concerns. Since it is possible to differentiate minor from major problems through the method used in marking the inventory, students may give expression to the intensity of their problems as well. Analysis of responses and group scores indicated that:

1. Most student concerns may be classified into the health education areas of sleep, rest, and relaxation; mental health; personal health; and nutrition. "Not getting enough sleep" ranked first among minor problems. "Not knowing how to study effectively" ranked highest among both major concerns and total combined problems marked by students; nearly half were troubled by this problem.

2. Although the twelfth grade reported a greater mean number of problems than the tenth grade, the difference between scores was not statistically significant.

3. A significant difference was found between male and female students in the number of health problems they reported on the Check List (.05).

Table 3 lists the number of B10 and A12 participants, their mean number of combined problems and standard deviations, and the significance of the difference between means. The A12 group expressed a greater mean number of concerns than the B10 group. The standard deviations show the B10 students have a greater spread or variance in the number of problems reported.

Table 4 lists the number of male and female participants, their mean num-

TABLE 3.—A COMPARISON OF THE MEAN AND STANDARD DEVIATION OF COMBINED PROBLEMS FOR MALE AND FEMALE STUDENTS

	No. of Students	Mean	S.D.	t	S.E. Diff.
B10	488	12.55	9.32		
A12	471	13.29	8.68	1.2751[a]	.5819
Total	959	12.91	9.02		

[a] Not significant.

TABLE 4.—A COMPARISON OF THE MEAN AND STANDARD DEVIATION OF COMBINED PROBLEMS FOR MALE AND FEMALE STUDENTS

	No. of Students	Mean	S.D.	t	S.E. Diff.
Male	487	12.28	9.19		
Female	472	13.57	8.79	2.28[a]	.5813
Total	959	12.91	9.02		

[a] Significant at 5 percent level of confidence.

ber of combined problems and standard deviations, and the significance of the difference between means.

Among the four groups in the sample population, males reported the fewest problems and B10 students showed greatest variance in the number of concerns checked. Range of scores for the B10 group was from 0 through 59 and 0-56 for the A12 group.

In an effort to provide information relative to students' health status, results from health examinations and personal history questionnaires were utilized. These data showed that:

1. A total of 721 health defects was found among 52 percent of the student population.
2. Orthopedic, dental, visual, and skin defects were observed most frequently. (These findings have implication for the instructional areas of personal health and dental health.)
3. A significant difference in the number of defects observed in health examinations exists between male and female students (.05).
4. Although a greater number of health defects was reported for tenth than for twelfth grade students, the difference was not statistically significant.
5. From the results of personal history questionnaires, poor health habits were evident for students in the areas of nutrition; consumer health; sleep, rest, and relaxation; and stimulants and depressants.

Table 5 shows that the tenth graders had a greater mean number of total health defects than the twelfth graders. Postural deviations ranked first and dental defects ranked second among B10 and A12 groups. No abnormalities were noted for approximately 50 percent of B10 students and 48 percent of A12 participants.

TABLE 5.—A COMPARISON OF THE MEAN AND STANDARD DEVIATION OF DEFECTS FOR B10 AND A12 STUDENTS

	No. of Students	Mean	S.D.	t	S.E. Diff.
B10	488	.787	.947		
A12	471	.715	.830	1.2522[a]	.0575
Total	959	.752	.892		

[a] Not significant.

TABLE 6.—A COMPARISON OF THE MEAN AND STANDARD DEVIATION OF DEFECTS FOR MALE AND FEMALE STUDENTS

	No. of Students	Mean	S.D.	t	S.E. Diff.
Male	487	.600	.788		
Female	472	.909	.962	5.4315[a]	.0569
Total	959	.752	.892		

[a] Significant at 5 percent level of confidence.

Table 6 shows the number of male and female participants, their mean scores and standard deviations, and the significance of the difference between means. Boys had approximately half the number of defects that girls had. Orthopedic deviations ranked first among female and second among male groups, and the reverse situation is noted for dental defects. No anomalies were evident for 55.6 percent of boys and 41.3 percent of girls.

Among the four groups in the sample population, males had the fewest health defects, and females showed the greatest variance in the number of deviations reported. A maximum of five defects was observed for several individuals.

Table 7 shows extremely low correlations among the variables of the study. There is little indication from this evidence of a tendency for students with higher LeMaistre inventory scores to have fewer health problem scores and defects.

TABLE 7.—COEFFICIENT OF CORRELATION OF SCORES ON THE LEMAISTRE HEALTH INVENTORY, THE MOONEY PROBLEM CHECK LIST, AND THE REPORTED NUMBER OF HEALTH DEFECTS FOR 959 STUDENTS

	"r"	S.E.
Mooney Problem Check List and the LeMaistre Inventory	—.06	7.89
Mooney Problem Check List and the reported number of defects	.002	.892
LeMaistre Inventory and the reported number of defects	.043	.891

Although application of correlational techniques revealed no statistically significant relationship among health behavior scores, the number of health problems students report, and their health status, from a comparison of the rank order of areas for the various instruments, certain relationships are apparent. For example, the area of sleep, rest, and relaxation seemed most troublesome to students; they knew least about the items in this area; and personal data questionnaires showed that their habits in relation to the area were poor. Similar comparisons are possible regarding the areas of personal health, nutrition, and consumer health.

A comparison of the findings from the *Check List* with the results of health screening examinations indicated that students generally tended to overestimate the nature and extent of their health problems. For example, approximately half of the female and one-fourth of the male students reported weight problems; however, endocrine and nutritional disorders were noted for less than 5 percent of the group. Evidence of student weaknesses in terms of health knowledge, attitudes, practices, and problems were summarized, and specific needs were listed for each of the 13 areas commonly used in planning the scope of the health education program.

Health Education Implications from the Study

It was possible to identify health education needs of high school students from an analysis of the data collected from a variety of sources. These needs

were identified in an attempt to make some evaluation of the effectiveness of health education in selected secondary schools of Los Angeles. Although little or no statistically significant relationship was found among students' scores on the various techniques which were used to identify needs, it was possible to note an interrelationship among the rank order of certain areas.

In light of the findings, the following implications are evident for health and counseling services, as well as for the administrative and teaching staffs:

1. There is a need for a definite block of time allotted for health education at the high school level.
2. There is an apparent need for more intensive health counseling and follow-up program to assist students to interpret their health problems more realistically and to encourage the correction of remediable defects.
3. The need for a more intensive counseling and guidance program is indicated for twelfth grade as well as tenth grade students.
4. There is evidence of the need for health and counseling services personnel and teaching staff to work jointly in an effort to assist students to interpret their problems realistically, to resolve those which are present, and to learn how to prevent others from developing.
5. Since the school has a supportive, but very important role in health education, it was concluded that health and counseling services personnel, teachers, and others must work with parents and family physician and dentist to help resolve student problems.

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(Submitted 1/15/60)

Thurstone Scale for Measuring Attitudes of College Students toward Physical Fitness and Exercise

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Abstract

Employing modified Thurstone techniques, two equivalent forms of an equal-appearing intervals attitude scale were constructed around the topic "physical fitness and exercise." Experimental test items were subjected to an extensive refinement process preceding the formulation of the final alternate test forms. Validity of the test was based upon authoritative opinion and expert judgment. A reliability coefficient derived from test, retest sampling was .83 ± .06. A correlation coefficient of .87 ± .03 was obtained on the parallel test forms.

ATTITUDE MEASUREMENT by the method of equal-appearing intervals was developed by Thurstone, as an application of psychophysical technique to scaling and represents an attempt to develop a rational scale. This means of attitude scale construction is one of two so-called classical techniques (the other being the method of summated ratings) (6) used most extensively in attitude and opinion research since the early 1930's. However, in the areas of health and physical education, few attempts have been made to apply the method in the development of specific attitude instruments. In the study to follow, the investigator has sought to construct a valid and reliable equal-intervals attitude scale around the attitude object "physical fitness and exercise," applicable for use with college students.

Definition of Attitude

For purposes of the present study, attitude as a general concept was defined after Edwards as "the degree of positive or negative affect associated with some psychological object" (2).

By affect is meant feeling—like or dislike, favor or disfavor, positive inclinations or negativity—toward a psychological object. The object, in turn is referred to as ideas, ideals, points of view, institutions (or their constituents), or persons capable of engendering an affective response.

In these terms, then, the attitude scale developed reflected a continuum of viewpoints (favorable to unfavorable) surrounding physical fitness and exercise—the psychological object.

Method

Formulation of the Test Items. In the construction of an equal-appearing intervals scale, an extensive number of attitude-opinion statements must be

collected to be judged by a panel of experts. These may be compiled intuitively, from literature sources, or from oral statements made about a topic under consideration. The only criterion according to Thurstone is that such statements represent as many views as possible (11). For the present study statements were gathered by using a sentence completion test with college freshmen (8). Seventy-two physical fitness and exercise opinion statements were derived.

Evaluation by Judges. Twenty judges, professors of health and physical education from five universities, were provided mimeographed lists of the statements with these instructions:

> Assume that each of the attitude statements reflects a point of view that can be rated on a five-point scale: 1—very unfavorable; 2—unfavorable; 3—neither favorable nor unfavorable; 4—favorable; and 5—very favorable. Evaluate each item, on this basis, on the IBM answer sheet enclosed by marking the appropriate answer category between one and five. Use the IBM graphic pencil for this purpose.
>
> It is important that you rate the statements independently of the way you feel about the topic to which the statements are related. Of course your attitudes are not being tested; however, your ratings on the statements will provide the criteria upon which the statements will be scaled for later use with college students.
>
> Further, it is important that you use *all* of the *five* categories for the classification of the statements. Therefore, after you have judged the items, marking their scale values, it may be necessary to reevaluate your choices to be sure that about an equal number of 1's, 2's, 3's, etc., through 5 have been assigned.

As may be noted from the above instructions, the procedures of the study were a slight departure from the original Thurstone techniques. Items were mimeographed instead of presenting them on individual cards for judgments; five instead of the usual 11 sorting categories were used; 20 rather than 200 to 300 judges were employed. Based on research findings subsequent to Thurstone's early work, the newer time saving methods appear to be as valid (3, 9, 12).

Distributions of the judgments were tabulated graphically to determine the frequency with which each item was placed in the categories one through five. Two statistics were then exacted from each of the frequency distributions: the median and Q, the distance between the 25th and 75th percentiles.

These statistics—Q's and medians—serve as the criteria for building the equal-intervals attitude scale. The median becomes the scale value of the item as reflected by its position between one and five on the favorable to unfavorable attitude continuum. Q, interquartile range, is actually a measure of ambiguity or other fault in the attitude statement. If Q is small, it indicates relatively high agreement among judges about the position of the statement on the attitude continuum. If Q is large, it is indicative of disagreement among judges making the item unsuitable for use in the scale (2).

Selection of the Test Items. Choosing only those statements evenly scaled (with median values 0.2 points apart) having small Q values, items were arranged in order of their scale values, after the method of Sigerfoos (10) and test forms A and B, consisting of 19 items each, were derived. The test appears here.

The following items are not designed to test your knowledge. Instead, they are meant to explore some of your feelings and points of view toward certain health topics. There are no *right* or *wrong* answers. Further, your responses will not be made known to other students nor will they be used for grading purposes in this course. Please give a thoughtful and honest response to each item.

Directions: Read each item carefully and circle the number opposite each item with which you agree. Make *no marks* on the numbers opposite the items with which you *disagree.* Remember, circle the number only of the items with which you agree; your disagreement with the items is indicated by leaving the numbers of the items blank. There is no time limit but work rapidly.

FORM A

(1.1)[1] Physical fitness activity is the lowest type of activity indulged in by man.
(1.3) Man has outgrown the need for physical fitness programs.
(1.5) Physical fitness activity programs are necessary only in wartime.
(1.7) Physical fitness activities are the least civilized of man's activities.
(1.9) Physical activity should not be stressed so much in our present culture.
(2.1) Planned physical activity programs have limited value.
(2.3) Physical fitness activity is unnecessary.
(2.5) The values of physical activity are debatable.
(2.7) Physical fitness activity should be left to the individual.
(2.9) Physical fitness programs are too soft.
(3.1) Physical fitness activities appeal to man's highest nature.
(3.3) Physical fitness is a most important aspect of life.
(3.5) Physical fitness activities have not proved indispensable to society.
(3.7) Physical fitness activities are retained in the world because of their value to mankind.
(3.9) Physical fitness programs are not sufficiently appreciated by college students.
(4.1) Physical fitness activities are vital to life.
(4.3) Physical activity benefits everybody.
(4.5) Physical fitness activity programs should be stressed.
(4.7) Physical fitness activity is a "must" in today's world.

FORM B

(1.1) Physical activity is a curse to modern men.
(1.3) Physical fitness activities are "anti-intellectual" in effect.
(1.5) Physical activity programs are an enemy to intellectual development.
(1.7) Physical fitness is not worth the effort required.
(1.9) Physical activity programs are more bad than good.
(2.1) Physical fitness activities should be planned only on an individual basis.
(2.3) Physical activity is not as important as intellectual activity.
(2.5) Physical activity programs are decreasing in their value to mankind.
(2.7) There are as many good as bad points in physical activity programs.
(2.9) The world could not exist without physical activity programs.
(3.1) Planned physical activities develop good character.
(3.3) Compulsory physical activity programs should be kept to a minimum.

---

[1]The scale values indicated in parentheses to the left of each test item are listed with decimal points only for presentation purposes here. When using the instrument in testing, items are given three numbers (without decimals) for convenience in scoring. The first of the three refers to item number on the test; the last two numbers indicate scale values. Thus, the subject upon testing sees the numbers, 111, 113, 115, 117, etc., respectively to the left of each item. This method of numbering was utilized to minimize the possibility of a suggested response pattern for the subject.

(3.5) Physical activity programs are in the process of change and will come out for the better.
(3.7) Compulsory physical activity programs should be enforced in all schools.
(3.9) Physical activities strengthen moral development.
(4.1) Physical fitness activities are increasing in their value to mankind.
(4.3) Physical fitness activities are valuable for maintaining health.
(4.5) Physical fitness activities are not sufficiently practiced by college students.
(4.7) Planning physical activity is fundamentally a sound practice.

Scoring method. Scoring the scaled test is relatively simple. Taking only those statements with which the subject has agreed, an attitude score is taken to be the midpoint of numerical scale values of items that may be regarded as indicative of the location of the subject on this particular psychological continuum. The subject's score thus is the median value of the statements marked (2).

For example, if the subject indicated an agreement with seven items having scales values of 2.5, 2.7, 3.5, 3.7, 4.1, 4.5, and 4.7, the value of 3.7, the median item value and thereby his score, represents the relative position of that subject on the selected attitude scale range.

Validity

The most trying problem in constructing attitude instruments is validation. How does one know that the test constructed by the method of equal-appearing intervals does the work that it is employed to do? The approach made here to the validation question was logical-judgment consensus.

Expert persons, knowing a field sufficiently well to judge a test item, may be employed to evaluate logical validity (1). Twenty such competent judges, in this case, were employed. Statistical treatment of the judgments secured, as previously detailed, provided an objective consensus of expert opinion.

The crucial question for the validity of an equal-appearing intervals scale is, however, whether or not scale values obtained from judges are independent of the judges' attitudes toward objects in question. Results from several investigations point to a conclusion that competent judges are able to make an absolute judgment about the scale position of an item independently of their own attitudes on the matter (7). In fact, McNemar contends that all attempts to disprove Thurstone's assumption that judges may make independent scale value assessments have failed (5).

In the present study, directions to the judges were written to be explicit, even to the extent of indicating that about an equal number of items be assigned to each sorting category. Such thoroughness of instruction apparently is not only advisable, but, as a recent study shows, necessarily vital as a prerequisite to judgment validity (4).

Reliability

Repetition and parallel forms were used to determine the measure of reliability of the attitude scale. After administering the test to 300 Southern Illinois University freshmen students, papers were assigned numbers from

which 50 were drawn randomly. Following a three-week time interval, the test was re-administered to these subjects. The test, retest coefficient of correlation between scores was .83 ± .06, high enough to predict a satisfactory measurement consistency.

The correlation coefficient on parallel forms of the test, N being 300, was .87 ± .03. Satisfactory coefficients usually reported for two forms of the same equal-appearing intervals scale was above .85 (3).

Discussion and Use of the Test

As indicated in a prior section, Thurstone techniques in attitude scale construction are traditional, structured, and somewhat form bound. The method requires that the test subject be consciously aware of his opinions and attitudes about a topic; latent attitudes apparently are not measured.

These drawbacks, however, are offset somewhat by certain other advantages inherent in the method. Such scales are relatively precise and objective and lend themselves to uniform interpretation. Quantitative scores are derived. Preparation of the scales also involves standardized statistical methodology—they are built up independently of subjective distortion on the part of a single investigator.

The topic of the present test, physical fitness and physical activity, has received considerable attention recently. Points of view on the matter, while varied, have largely been subjective. It is hoped that through the use of the scale herein presented attitudes of college populations may be more objectively and precisely measured.

Conclusions

The following conclusions are warranted on the basis of the study:

1. Forms A and B of the attitude scale presented herein proved to be a reliable instrument for use with college students. Results of the validation procedures permit a high degree of confidence in its validity.
2. Forms A and B proved to be equivalent and may be used interchangeably.
3. The scale is sufficiently precise, objective, and easy to administer and score to permit its practical use in the college classroom.
4. The scale provides a logical means of appraising attitudes of college students toward physical fitness and exercise prior to instruction as well as after instruction.

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(Submitted 2/17/60)

Relationship between Intelligence and the Effect of Mental Practice on the Performance of a Motor Skill

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Abstract

Thirty-five boys were given nine periods, each of five minutes duration, of mental practice at the underarm basketball free throw. They were tested for accuracy of throwing before and after the mental practices. The significant gain obtained could not be related to the initial score or to the intelligence of the thrower.

EARLY RESEARCH BY Freeman (2) indicated that mental work was accompanied by variations in muscle tensions. From this he concluded that "photographic registration of the thickening of several muscle groups provided valid and important evidence of the spread of neuromuscular activity during mental work." Later work by Shaw (4) showed that there was an involuntary muscle activity accompanying the mental practice of a motor skill. Buxton (1), in a publication from a survey of the literature on reminiscence, noted that greater improvement in skilled performance after practice occurred if intervals of rest were allowed between the tests and concluded that this benefit was the result of reminiscence. Vandell (7) and Twining (6), working individually, concluded that mental practice probably improves the performance of a motor skill. Morrisson (3), in his book *Better Golf without Practice*, thinks that mental practice does improve performance at golf.

In 1952 Steel (5) tested the effects of mental practice on motor learning in such a way as to enable statistical treatment of the data. He found that mental practice did not improve a ball-throwing skill to a statistically significant degree but concluded that "daily mental practice of a motor skill produces a substantial increase in that skill."

Procedure

The physical skill selected for the test was the underarm basketball free throw. It was selected as a skill in which physical practice could be prevented. This was possible since the apparatus for physical practice was in a school gymnasium and its use was controlled by the investigator. Further it was a skill that was new to the sample and the effects of previous experience in the skill could be discounted.

Children in England, at 11 years of age, sit a secondary school selection examination. Those whose performance in this test place them in the highest percentage bracket are offered places in the secondary grammar schools. Those who have not the highest academic achievement are placed at either secondary technical or secondary modern (general) schools. This study was made in May 1959 with 12-year-old boys from a mixed secondary modern school in Lancashire, England. On admission to the school, the children had

been given another test of academic attainment. On the basis of their results in this test they were placed in groups (streams) of 30, such that some level of homogeneity was achieved within the stream. These streams were then numbered AA, A, BB, B, C, D, E. Movement of children between the streams was fairly fluid, the adjustments being made on the basis of teacher recommendation and the results of end-of-term attainment tests. The boys used in this study were from the first six streams of the first year pupils of the school. They were asked to participate in the project, the exact nature and form of which was not revealed to them.

The boys were then given 10 throws at a basketball goal from the free throw line. They were allowed to use any method of throwing; by arranging boys to retrieve the thrown balls, unnecessary movements of the thrower's feet were avoided. Size four, brown polyvinyl balls were used throughout the experiment. Each boy was allowed 10 throws and the number of successful ones was noted as his initial score. This was an attempt to measure any ability that the boys might have for accuracy of throwing this size of ball.

The streams were then taken in pairs (AA and A; BB and B; C and D) for nine daily sessions of five minutes mental practice. The practices consisted of explanations of the technique of the throw. The boys, who were seated, were asked to picture themselves performing the throw as the writer described it (instructor-lead practice). They were then invited to mentally perform the throw without moving and without the spoken description (individual practice). Then a short instructor-lead practice was held. After the first practice, which was general description of the skill and practice, the later practices consisted of highlighting a particular part of the technique and then individual practices of the whole technique followed by instructor-lead practices. In the last minute of practices 8 and 9, the boys were invited to go through in their minds their final throws, i.e., they were to picture themselves from the time they left the bench in the gymnasium, through the throws, and until they were back on the bench.

The timing for the practices was by stopwatch. Care was taken to follow exactly the same set of instructions for each stream. A register of attendance was maintained and at the end of the nine sessions the 35 boys who had 100 percent attendance were tested in the skill that they had been mentally practising (the two-handed underarm basketball free throw). As in the initial test the throws were taken from the free throw line. Other boys retrieved the thrown balls and the thrower did not have to move his feet unnecessarily.

The intelligence quotients of the boys who completed the tests were obtained from the Northern Tests of Educability (England) which were used in the school as part of the assessment for streaming the children on intake.

Results

It was first necessary to establish if there was a significant difference between the initial and the final scores. The initial and final scores were correlated, using Pearson's product moment method and a value for r of −0.059

was obtained that was insignificant. Fisher's t test was then applied to the data, using the formula for uncorrelated means. The difference between the mean of the initial scores and the mean of the final scores of the group was significant at the 5 percent level (f test 6.81 with 34 degrees of freedom and $t = 2.61$ with 34 degrees of freedom). As the mean of the final scores was higher than the mean of the initial scores, there had been a significant improvement in motor performance in the tests over the period of the mental practices. Steel's (5) work would indicate that this improvement is due to the mental practice.

Effect of Initial Scores

The effect of initial score on final score had been shown to be insignificant by the Pearson's correlation ($r = -0.059$). The effect of initial score on improvement was investigated by the chi square technique with Yates' correction because of the coarse nature of the groups involved. The value of chi square did not reach the value for 5 percent significance, and the null hypothesis was not discarded. Thus the initial score, possibly a guide to a motor ball-throwing ability, did not influence the individual's score in the final test or any improvement that was made.

Effect of Intelligence

The data were correlated, using Pearson's product moment method and r converted to z to give a correlation for the equivalent normal distribution for the sample. The mean of the intelligence quotients of the sample was 103.8 with a standard deviation of 9.1. The results obtained are shown in Table 1.

The sample was then divided into groups on the basis of intelligence, a higher intelligence group (intelligence quotients from 106 to 117) and a lower intelligence group (intelligence quotients from 83 to 105). The mean gain of each of the groups was then obtained and the difference tested for significance by Fisher's method. The results are shown in Table 2.

TABLE 1.—RELATIONSHIP BETWEEN INTELLIGENCE AND INITIAL, FINAL SCORE, AND GAIN

Scores	Mean	σ m	Correlation with Intelligence			
			r	5% Sig.	z	σ z
Initial Score	0.77	0.76	+0.14	↑	0.14	↑
Final Score	1.46	1.34	−0.11	0.33	0.11	0.18
Improvement	0.70	1.58	−0.10	↓	0.10	↓

TABLE 2.—DATA FOR COMPARISON OF MEAN GAIN OF HIGH AND LOW INTELLIGENCE GROUPS

I.Q.'s	M (I/8 ± FS)	S.E.	t
106-117	.67	.43	.01
83-105	.71	.37	

This value of t is not significant at the 5 percent level and thus there was not a significant difference between the gain of the higher intelligence group and the lower intelligence group. Since 14 of the boys had the same initial score (0), it was possible to test the relationship between intelligence and improvement in this situation. The boys were divided into a higher and a lower group on the basis of their intelligence. The data on improvement were utilized twice. The first time improvement was divided into two groups: group one to contain improvements of four, three, and two goals; group two to contain one goal improvements and no improvements. The second time used, the division was made so that group one contained four and three goal improvements and group two the remainder. Both the calculations are listed in Table 3.

TABLE 3.—HIGH AND LOW INTELLIGENCE GROUPS AND IMPROVEMENTS AFTER AN INITIAL SCORE OF 0

Intelligence Quotients	Improvements		Improvements	
	4,3,2	1,0	4,3	2,1,0
102-117	4	4	2	6
83-101	5	1	2	4
Fisher's Exact Probability	$p = 0.21$		$p = 0.42$	

From these results it is apparent that in the sample used for this experiment, a relationship between the improvement in motor performance in the test after mental practice and the intelligence quotient of the participant is not evident. Within the limits of this study the high IQ, with its implied ability to appreciate relationships and to analyze situations, did not appear to aid a boy in his performance of this motor skill after specific mental practice.

Discussion

The study was designed to discover any relationship between intelligence and the ability to benefit in motor performance from mental practice. Previous work had indicated that mental practice did improve motor performance, and in this sample a significant difference ($t = 2.61$ for 34 degrees of freedom) was obtained between the mean initial score and the mean final score in the test.

Inherent hand-eye coordination such as might be measured by a high score in the initial test did not appear to influence the final test scores. Chi square calculations for initial score/final score and initial score/improvement as well as a product moment calculation for initial score/final score (-0.06) were statistically insignificant. Though not significant, there was a trend for greater improvement to be shown by boys who scored low marks in the initial test. This would be expected on grounds of chance alone as boys who scored 0 in the initial test could not regress. This would tend to give an over-all picture of improvement in the retest situation for these boys.

The influence of intelligence was considered with product moment calculations for intelligence/initial score ($r = +0.14$), intelligence/final score ($r = -0.11$), and intelligence/improvement ($r = -0.10$). A significant figure was not reached in any of these calculations. When grouped into higher and lower intelligences and the mean improvements of the two groups compared, a significant difference was not obtained ($t = 0.01$ for 34 degrees of freedom). When boys with the same initial score were placed in higher or lower intelligence groups and the mean improvements compared, the difference could occur by change more frequently than one in five. From these results it is evident that, in the sample, intelligence did not influence initial score, final score, or gain in the tests given. Thus the improvement that the sample as a whole obtained over the period of mental practice was not related significantly to the intelligence of the members of the sample.

As neither initial score nor intelligence appeared to be influencing the gain in motor performance after the mental practice this improvement must have been caused by some other factor or factors. One factor could be motivation. A boy who is recognized by his equals as a good player would be expected by his group to perform well in these tests. It was noted that some of these good players did rather poorly in their initial test. There would be great motivation in their case to perform well in the final test. Another factor might be that of games ability. A boy with an aptitude for games might be expected to acquire the skills of a game whatever the manner of instruction. Further study on the factors which control the ability to improve motor performance by mental practice should prove rewarding.

In Steel's study the skill used, ball throwing, was known to the group, and their mental practice would have a basis of motor experience on which to mature. In this experiment such a background of motor experience was not available to the sample. Physical experience of the skill was only obtained in the test itself. It is possible that a gain in performance could result from this experience. However, the probability of a significant improvement in test performance from the physical experience obtained during the test is thought to be low, but the absence of a control group from the experimental design does not allow definite conclusions to be made on this point. It would be interesting to discover whether mental practice is more effective if the individual has had some motor experience of the practice than if the individual is without such a background.

It is now felt that the skill used for the test in this study was difficult to acquire. (This is indicated by a low average final score.) There was a fairly narrow range of scores and discrimination was correspondingly less effective. Any future experiment carried out along these lines should attempt to obtain greater discrimination. This could be done by (a) increasing the number of throws, (b) evolving a method of giving credit for a near miss such as hitting the rim, or (c) by changing the skill. Further it was believed that the experiment as a whole was rather negatively skewed because the poor performers initially could not regress far and, by chance, tended to improve. The low

scores would also tend to give relatively low statistical reliabilities for these scores. A higher average score, such as could be obtained by any of the three methods listed above, would have removed these difficulties.

Conclusions

1. In a motor test there was a significant improvement in the mean average final score on the mean average initial score of the group after mental practice ($t = 2.61$ significant at 5 percent level).

2. This improvement was not significantly related to the initial score in the test or to the intelligence of the individual performing the test.

3. It was felt that the level of difficulty for the sample, of the skill used in the test, was too high to give a wide spread of performances and thereby good discrimination.

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Use of Harmful Health Misconceptions as a Basis for the Selection of Subject-Matter Areas and Course Content in College Health Classes[1]

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Abstract

The Borozne Health Information Opinionnaire was used to determine the amount and kind of harmful health misconceptions believed by students in basic health information classes in four-year colleges in the state of Indiana, and whether they were affected by the following factors: age, grade level, sex, race, course background, rural or urban background, marital status, major area of academic preparation, school attended, geographic location, and religion. Findings revealed (a) the most prevalent harmful health misconceptions; (b) subject-matter areas which contained the greatest percentage of harmful health misconceptions believed by the students; and (c) the existence of significant differences between the mean harmful health misconception scores of the sex, race, marital status, grade level, major area of acadmic preparation, and course background subgroups.

THE PURPOSE OF this study was to use harmful health misconceptions as a partial basis for the selection of subject-matter areas and course content in college health classes. This was accomplished by determining the amount and kind of harmful misconceptions that were believed by the students in basic health information classes in four-year colleges in the state of Indiana, and whether they were affected by the following factors: age, grade level, sex, race, course background, rural or urban background, marital status, major area of scholastic preparation, school attended, geographic location, and religion. Through an analysis of the data, recommendations can be made concerning the teaching of health as regards grade level, general and specific content, and subject-matter areas to be taught.

Procedures

Particular emphasis was placed upon the preliminary planning, the selection of a suitable instrument to measure harmful health misconceptions, the selection of a sample of students, the administration of the instrument to the sample of students, and the organization and analysis of the data.

The "horizontal analysis" procedure was used in the preliminary planning

[1] This study was made in partial fulfillment of the requirements for the degree of Doctor of Health and Safety in the School of Health, Physical Education, and Recreation, Indiana University, Bloomington, Indiana, September 1959.

of this study, in order to meet and solve problems in a logical sequence. Based on the criteria of validity, reliability, objectivity, ease of administration, ease of scoring, economy, no indication that a misconception study is being made, freedom from statements pertaining to religion and sex, item soundness, interest to the examinees, utility, and development value, the Borozne Health Information Opinionnaire was selected for measuring the harmful health misconceptions of the students taking part in this investigation.

Through correspondence with registrars of Indiana colleges and the teachers of basic health information classes in those colleges, permission was obtained for the administration of the Borozne Health Information Opinionnaire at ten schools.

A pilot study resulted in a standardized procedure for the administration of the instrument, used by the writer throughout the collection of the data. A personal visit was made to each of the ten schools cooperating in this study, and 630 completed opinionnaires were collected along with certain personal information about each of the participants.

Analysis of the data was concerned with determining the percentage of harmful health misconceptions in each of seven subject matter areas, the percentage of students who believed each of the harmful health misconceptions, and the significant differences that occurred between the mean harmful health misconception scores of students divided into groups according to age, grade level, sex, race, course background, rural or urban background, marital status, major area of academic preparation, school attended, geographic location, and religion. For subgroups of two categories each, significant differences in mean scores were determined by the critical ratio technique. In situations in which more than two categories existed, significant differences in mean scores were determined by an analysis of variance. The five percent level of confidence was used to evaluate these statistical tests.

Findings

The seven subject matter areas, their respective number of total possible responses, actual harmful health misconceptions believed, and the percentage of harmful misconceptions believed by 630 college students are shown in Table 1.

The highest percentage of harmful health misconceptions was 37.59 percent, in the exercise subject matter area; the lowest was 11.75 percent in the mental hygiene subject matter area. The greatest spread in the percentage of harmful health misconceptions believed between adjacent subject matter areas was first aid with a value of 28.65 percent and exercise with a value of 37.59 percent.

The individual harmful health misconceptions were ranked from high to low according to the percentage of students believing each item. The 50 most prevalent harmful health misconceptions and the percentage of students believing each are listed in Table 2.

The harmful health misconception believed by the greatest percentage

TABLE 1.—RESULTS OF THE ADMINISTRATION OF THE BOROZNE HEALTH OPINIONNAIRE TO 630 SELECTED COLLEGE STUDENTS IN INDIANA

Subject Matter Areas	Number of possible responses	Number of harmful health misconceptions believed	Percentage of harmful health misconceptions believed
Exercise	6300	2368	37.59
First Aid	5040	1444	28.65
Personal Hygiene	17010	4372	25.70
Drugs and Patent Medicines	6300	1287	20.43
Care and Prevention of Disease	15750	3015	19.14
Nutrition	23310	3493	14.98
Mental Hygiene	8190	962	11.75

TABLE 2.—THE PERCENTAGE OF STUDENTS BELIEVING EACH OF THE 50 MOST PREVALENT HARMFUL HEALTH MISCONCEPTIONS IN THE BOROZNE HEALTH OPINIONNAIRE

Rank order	Harmful health misconceptions	Percent believed
1	A mouthwash is healthful because it helps kill germs in the mouth and throat	82.22
2	A daily bowel movement is always necessary for good health	77.30
3	The main purpose of a dentifrice is to kill bacteria	62.54
4	A blind person has a keener sense of touch and hearing because of the strength normally in the eyes has gone to the other sense organs to make them more acute	61.43
5	It is a bad health habit to drink water while you exercise	56.35
6	Arch supports should be used by all people with flat feet	55.87
7	Application of butter is an effective treatment for burns	54.76
8	The main function of perspiring is to eliminate body poisons	52.38
9	Alcohol is a stimulant	52.22
10	The use of lanolin restores the natural oils lost as a result of washing the hair	52.22
11	Six-year molars are replaced with second teeth	50.48
12	The best thing to do when your muscles are stiff is to work the stiffness out by taking further vigorous exercise	49.05
13	Regular vigorous exercise increases a person's resistance to infectious diseases	48.89
14	The best way to lose weight is by exercising	46.35
15	Cutting or shaving a person's hair makes it grow faster and thicker	46.19
16	A good way to treat frost bite is to rub the frost-bitten part with snow	43.65
17	The cause of overweight in most cases is a lack of exercise	42.06
18	Wearing bathing hats or ear plugs while swimming will ensure protection for the ears	41.75
19	A good way to help a person get rid of hiccoughs is to frighten him	40.63
20	Once you stop exercising, muscle changes to fat	40.16
21	It is necessary for optimum health to keep the windows open in the bedroom at night	38.41
22	When training children one should recognize the fact that they are miniature adults and treat them accordingly	37.94
23	There are certain medicines that will prevent and cure the common cold	36.51
24	The immediate treatment to be given for sprain or strain should be the immersion of the affected part in hot water	36.03

25	Overexercise is a cause of heart disease	35.71
26	It is a good idea for all persons to take vitamin pills daily	35.71
27	Hot food is more nutritious than cold food	34.76
28	People with too much acid in their system should avoid all citrus fruit	33.97
29	Being massaged regularly is effective in weight reduction	33.81
30	Persons can clean their blood by eating certain foods	30.79
31	People should use aspirin to cure a cold	29.52
32	There are no living germs in pasteurized milk	29.52
33	A cancer can be arrested, but it can never be completely cured	29.37
34	Chewing on bones or hard objects strengthens the teeth	28.73
35	The less you eat during hot weather the less you will feel the heat	28.25
36	Overweight is usually due to faulty glands	28.10
37	Plenty of exercise in the fresh air is the best treatment for tuberculosis	27.94
38	People who are strong and healthy are sufficiently fortified against communicable diseases	27.14
39	The occasional use of sleeping pills without a doctor's advice is permissible	26.51
40	Brushing the teeth after every meal is a sure way of stopping tooth decay	26.19
41	Acid and alkaline foods should not be eaten together	26.03
42	The craving for a certain food is an indication that the system needs that particular food	25.40
43	A person who has mental illness lacks will power	24.92
44	A pain in the right side usually means that one has appendicitis	24.29
45	Sugar diabetes is caused by eating too many sweets	23.17
46	A pain in the lower back is generally a sign of kidney disease	22.70
47	Iodine is the best treatment for infection caused by stepping on rusty nails	22.22
48	Eating between meals causes most children to have poor health	20.48
49	The best way to treat a black eye is to put a piece of raw meat on it	20.32
50	A child's natural likes and dislikes will lead him to choose a balanced diet	20.16

(82.22%) of the students partaking in this investigation was "A mouthwash is healthful because it helps kill germs in the mouth and throat." The harmful health misconception "A child's natural likes and dislikes will lead him to choose a balanced diet," was the least prevalent harmful health misconception.

Only two harmful health misconceptions were believed by more than 75 percent of the students; nine harmful health misconceptions were believed by more than 50 percent and less than 75 percent of the students; and 31 harmful health misconceptions were believed by more than 25 percent and less than 50 percent of the students.

The existence of significant differences in the mean harmful health misconception scores of selected subgroups within the study was determined. In subgroups (made up of two categories each) (age, sex, race, rural or urban background, marital status, religion, and geographic location), the null hypothesis was tested at the 5 percent level of confidence for the difference between the mean harmful health misconception scores, by the critical ratio technique. The subgroups and their respective size, mean score, standard deviation, standard error of the difference between the means, sampling error, critical ratio, and the existence of significant differences between the means are shown in Table 3.

Of the categories indicated in Table 3, the highest mean score was a value

TABLE 3.—THE EXISTENCE OF SIGNIFICANT DIFFERENCES BETWEEN MEAN HARMFUL HEALTH MISCONCEPTION SCORES OF SUBGROUPS MADE UP OF TWO CATEGORIES EACH

Subgroups	N	Mean	σ	σM_1-M_2	Sampling error	Critical ratio	Significant difference
Out-of-state	175	26.89	11.81				
In-state	455	26.89	12.33	1.07	0	0	No
Female	332	25.91	11.55				
Male	298	27.98	12.77	.97	2.07	2.13	Yes
White	608	26.58	12.00				
Negro	22	35.55	13.90	3.10	8.97	2.89	Yes
Single	541	27.77	11.89				
Married	82	21.73	12.58	1.49	6.04	4.05	Yes
20 years old and over	275	26.22	12.83	1.00	1.19	1.19	No
Under 20 years of age	355	27.41	11.63				
Protestant	525	26.90	12.03				No
Roman Catholic	86	26.70	12.90	1.50	.20	.13	
Rural background	192	26.71	11.54	1.03	.26	.25	No
Urban background	438	26.97	12.46				

of 35.55 scored by the group of 22 Negro students. The lowest mean harmful health misconception score was 21.73 scored by the group of married students. The size of the sampling error ranged from a value of zero for the in-state and out-of-state subgroup to 8.97 which occurred between the Negro and white students.

Four of the seven subgroups revealed no significant difference between their scores. These subgroups were geographic location, age, religion, and urban and rural background. Three of the seven subgroups revealed a significant difference between scores. These subgroups were sex, race, and marital status. Based on this investigation, the male students believed more harmful health misconceptions that the female students, the Negro students believed more harmful health misconceptions than the white students, and the single students believed more harmful health misconceptions than the married students.

In those subgroups made up of more than two categories each (grade level, previous college course background, major area of academic preparation, and school attended), an analysis of variance was performed. Bartlett's procedures as described by Edwards (9) were used to test for homogeneity of variance,

and where the results were justified, the t test was used to evaluate the differences between the means taken two at a time. These tests were all evaluated at the 5 percent level of confidence.

An analysis of variance indicated the existence of significant differences between the mean health misconception scores of students divided according to grade level. Specifically, the calculated t ratios were found to be significant for the following groups:

1. Freshmen believed more harmful health misconceptions than sophomores.
2. Freshmen believed more harmful health misconceptions than juniors.
3. Freshmen believed more harmful health misconceptions than seniors.

There were no significant differences between the mean harmful health misconception scores of seniors, juniors, and sophomores.

The existence of significant differences between the mean scores of students divided according to major area of academic preparation was shown by an analysis of variance. Specifically, the calculated t ratios were found to be significant for the following groups:

1. Physical education majors believed more harmful health misconceptions than elementary education majors.
2. Physical education majors believed more harmful health misconceptions than students majoring in related sciences.
3. Business majors believed more harmful health misconceptions than secondary education majors.
4. Secondary education majors believed more harmful health misconceptions than students majoring in related sciences.
5. Business majors believed more harmful health misconceptions than elementary education majors.
6. Students majoring in liberal arts believed more harmful health misconceptions than related sciences majors.
7. Business majors believed more harmful health misconceptions than students majoring in related sciences.
8. Business majors believed more harmful health misconceptions than religion majors.

There was insufficient evidence to show the existence of significant differences between the scores of all other possible combinations of students divided according to major area of academic preparation.

Significant differences were also indicated in scores of students divided according to previous college course background. Specifically, the calculated t ratios were found to be significant for the following groups:

1. Students with no previous college course background in courses related to health believed more harmful health misconceptions than students who had completed a nutrition course.
2. Students with no previous experience in college courses related to health believed more harmful health misconceptions than students having had both biology and hygiene.
3. Students with no previous college course background in courses related

to health believed more harmful health misconceptions than students having had both biology and first aid.

4. Students having college experience in biology believed more harmful health misconceptions than those who had completed a nutrition course.

5. Students who had completed a college course in hygiene believed more harmful health misconceptions than did students who had completed a nutrition course.

6. Students with experience in college biology believed more harmful health misconceptions than those who had completed both biology and hygiene.

7. Students who had completed a college hygiene course believed more misconceptions than those who had experience in both biology and hygiene.

8. Students with experience in college biology believed more harmful health misconceptions than did students who had experience in both biology and first aid.

9. Students who had completed a college course in hygiene believed more harmful health misconceptions than those who had completed both biology and first aid.

There was insufficient evidence to show significant differences between scores of all other possible combinations of students divided according to previous college course background.

There was insufficient evidence to indicate the existence of significant differences between the mean harmful health misconception scores of students divided according to school attended.

Conclusions

Within the limitations of this investigation, the writer makes the following conclusions:

1. The mean harmful health misconception score of 26.89 indicated that the students enrolled in Indiana colleges and attending basic health information classes believe harmful health misconceptions.

2. Strengths and weaknesses in health content and subject matter areas can be determined by measuring beliefs in harmful health misconceptions.

3. The subject matter areas of mental hygiene and nutrition seem to be the least important for inclusion in basic health information classes at the college level.

4. The subject matter areas of exercise, first aid, and personal hygiene seem to be most important for inclusion in basic health information classes at the college level.

5. When planning course content, college teachers do not have to be concerned with the factors of age, in-state and out-of-state background, religion, rural or urban background, and school attended.

6. Negro students need more assistance in eliminating beliefs in harmful health misconceptions than white students.

7. Previous college course background seems to be a factor affecting beliefs in harmful health misconceptions.

8. It appears that college freshmen need more assistance in the removal of beliefs in harmful health misconceptions than sophomores, juniors, and seniors.

9. It would seem that students majoring in physical education, liberal arts, business, and secondary education need greater assistance in eliminating beliefs in harmful health misconceptions than students majoring in related sciences, religion, and elementary education.

10. It appears that the elimination of harmful health misconceptions believed by unmarried students would require greater efforts than elimination of those believed by married students.

Recommendations

Based on this investigation, the writer makes the following recommendations:

1. Harmful health misconceptions should be used as a partial basis for selecting subject matter areas and content to be used in basic health information classes at the college level.

2. The subject matter areas of exercise, first aid, and personal hygiene should receive special emphasis in basic health information classes at the college level.

3. Special efforts should be made to remove harmful health misconceptions of all prospective teachers.

4. The greatest emphasis in basic college health instruction should occur at the freshman level.

5. There should be greater emphasis upon eliminating the harmful health misconceptions believed by the Negro population in Indiana colleges.

6. Special efforts should be made to remove the harmful health misconceptions of the male population of Indiana colleges.

7. Basic health information classes should be directed toward the removal of the harmful health misconceptions believed by unmarried students.

8. The variety in the number of harmful health misconceptions believed according to the previous college course background of the students indicates that this course background should be considered in planning the instruction in basic health information classes.

9. Teachers of basic health information classes should be professionally prepared to teach health and have an interest in teaching such courses.

10. There is a need for more qualitative studies in harmful health misconceptions involving various grade levels.

11. Studies in harmful health misconceptions should be conducted in other geographical locations.

12. The subject of harmful health misconceptions should be treated in all college courses related to health education.

13. Opinionnaires made up of harmful health misconceptions should be revised periodically. Recent research and medical advances may possibly eliminate certain items as misconceptions.

(Submitted 3/25/60)

Comparison of Four Approaches to Increasing Physical Fitness[1]

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Abstract

An attempt was made to study the relative effectiveness of four approaches to increasing physical fitness in male college freshmen. A freshmen orientation class was randomly divided into four groups of 12 students each to receive one of the following treatments: (a) calisthenics, games, and sports with a periodic knowledge of results; (b) calisthenics, games, and sports without a knowledge of results; (c) games and sports with a periodic knowledge of results; and (d) games and sports without a knowledge of results. The Indiana Motor Fitness Test was used to determine the subject's physical fitness index at the first, sixth, twelfth, eighteenth, and twenty-fourth class session. Knowledge of results seemed to have more effect on physical fitness than 15 minutes of calisthenics at the beginning of each class.

IT WAS THE purpose of this experiment to study the relative effectiveness of four different approaches to increasing the physical fitness status of male college freshmen. These four approaches were:

1. A program of calisthenics, games, and sports with the students receiving a periodic knowledge of results.
2. A program of calisthenics, games, and sports with the students receiving no knowledge of results.
3. A program of games and sports with the students receiving a periodic knowledge of results.
4. A program of games and sports with the students receiving no knowledge of results.

An attempt was made to determine if the psychological principle of informing students periodically of their progress or regression would be as effective for increasing physical fitness as participation in 15 minutes of strenuous calisthenics at the beginning of each class session.

Review of Literature

Numerous studies dealing with both of the experimental variables used in this study were found in the literature but none was uncovered which dealt with the combined effects of calisthenics and knowledge of results on physical fitness. Landiss (7) and Kistler (6) concluded that physical fitness could be improved by intensive conditioning programs. Wilbur (13) found that the formalized apparatus method did not necessarily

[1] This study was made in partial fulfillment of the requirements for the degree of Doctor of Education in the Physical Education Department of George Peabody College for Teachers in Nashville, Tennessee, under the sponsorship of Solon Sudduth, Ned Warren, and Raymond Norris.

show superiority over the sports method in increasing physical fitness. Manzer (9) and Arps (1) found that a knowledge of results did facilitate an increase in muscular output. Plowman and Stroud (10), Deputy (3), and Ross (11) emphasize that caution should be exercised in comparing the results obtained in laboratory experiments to everyday living. They point out that the degree to which the individual is motivated initially and the significance which he attaches to the outcome are very important considerations in assaying the effects of knowledge of results on improvement and achievement. A study by Johnson (5) substantiates the statement that, although learning occurs even when the experimenter attempts to withhold all knowledge of results, almost any means of giving any amount of useful knowledge of results is more effective, regarding measures of acquisition, than withholding knowledge of results.

Procedures

Every attempt was made to use the most objective methods which would introduce the least amount of unaccounted-for variability and thus make it possible to draw statistically sound inferences and generalizations from the findings.

Experimental Design. A Lindquist Type III Design (8), was used to run a complete analysis of variance to test the stated hypotheses. Lindquist explains the nature of this particular design in the following manner: "Suppose that a factorial experiment is to be performed with three factors, A, B, and C, with a possible total of ABC treatment combinations. In such situations, one of the treatment classifications (A) may be such that all treatments in that classification are administrable to the same subjects, but this may not be true of the other (B and C) classifications." In relating this design to the present experiment, it can be seen that the A treatment, or the one administrable to the same subjects, was the testing which was done every sixth class period. The results of these tests constituted the criterion for determining if the experimental variables under consideration had any observed effect on the physical fitness status of the subjects. The B treatments consisted of programs of calisthenics, games, and sports, and just games and sports. The C treatments were providing a knowledge of results and withholding a knowledge of results. Figure I illustrates the exact nature of the experimental design and shows pictorially the various combination of treatments which each of the four groups received.

Hypotheses. The four hypotheses tested in the experiment were:

1. There would be no combination of course content, knowledge of results, or periodic testings which would combine to result in an increase in physical fitness.
2. Knowledge of results would not facilitate an increase in physical fitness.
3. Physical fitness improvement would not be a function of course content.
4. The physical fitness status of the subjects would not improve over the experimental period.

The study was conducted at the .05 level of significance throughout.

Instrument. The Indiana Motor Fitness Test for High School and College Men (2) was used to determine periodically the subject's physical index. Four indexes were available but number two (chins plus push-ups) X (stand-

ing broad jump) was chosen due to the equipment needed in the execution of the test items.

Sample. The sample used in the experiment consisted of 48 male freshmen enrolled in a required physical education orientation course. The students were enrolled in the course on a first-come-first-served basis. These 48 boys were assigned on a random basis to one of the four groups, each of which received a different treatment. These subjects were considered to be a random sample of the male freshmen population at Shepherd College, Shepherdstown, West Virginia.

Administrative Procedures. Each of the four groups was assigned a different program on a random basis. Group C_1B_1 received a program of calisthenics, games, and sports with a periodic knowledge of results. Group C_1B_2 received a program of games and sports with a periodic knowledge of results. Group C_2B_1 received a program of calisthenics, games, and sports without a knowledge of results. Group C_2B_2 received a program of games and sports without a knowledge of results. (See Figure I.)

All four groups were tested with the chosen instrument at every sixth class meeting. Testing was done by the experimenter with the help of four student assistants. The two groups which received a periodic knowledge of results were presented with individual progress cards[2] at the class session immediately following the tests. Cards were distributed without comment, to minimize the possibility of students interpreting praise or reproof from the remarks.

The experiment began on September 15, 1959, and was terminated on December 10, 1959. The class met twice weekly during this period for one-hour periods (25 class sessions). Daily lesson plans[3] for each group were prepared by the experimenter prior to each class session. The calisthenics were administered at the beginning of each class session and were strenuous. They consisted of squat-thrusts, burpees, jumping-jacks, sit-ups, knee-bends, running-in-place, and trunk rotation. The exercises were taken from books by Duncan and Stafford (4) and by Steinhaus (12). The program for all groups, with the exception of the experimental variables, consisted of a unit on tumbling and gymnastics which included the forward roll, backward roll, head stand, and rope climbing; a unit on basketball which included practice and instruction in the fundamentals and actual game competition; a unit on dodgeball which included actual game competition; a unit which consisted of running relays; and a unit on instruction in beginning swimming.

Analysis of the Data

The first hypothesis tested in the experiment was the one of no ABC interaction, and this hypothesis was tenable (See Table 1). In the absence of an ABC interaction, the next hypotheses tested were the ones of no BC interaction, no AB interaction, and no AC interaction.

[2] A sample individual progress card will be furnished upon request.

[3] Daily lesson plans for each group can be found in the Appendix of the original manuscript.

All of these hypotheses were acceptable with the exception of the latter. The presence of this AC interaction indicated that there was some combination of the periodic testings, which constituted the A treatments, and knowledge of results, which constituted the C treatments, coalescing to provide unequal treatment means at the AC level. Figure II presents in graphic form a comparison of the individual group means for each of the periodic testings.

For the next logical step in breaking down the experiment, a Lindquist Type I Design (8), presented the most valid way to test the effects of the A treatments at the various levels of C. It appeared that there would be two such designs, one for each level of C.

Type I Design at Level C_1. The first hypothesis tested at the C_1 level was the one of no AB interaction, and this hypothesis was tenable (See Table 2). The main effects were then tested, and as shown in Table 2, a difference did exist in the A means at the C_1 level. The simple effects of A were then tested.

TABLE 1.—SUMMARY TABLE FOR TYPE III DESIGN

Source	d.f.	EX^2	s^2	F	$F_{.95}$
Between-Subjects	47	196154.80			
B (Calisthenics)	1	2082.71	2082.71	.53	4.08
C (Knowledge of Results)	1	8085.21	8085.21	2.05	4.08
BC (Know of Res-Calisthenics)	1	12456.00	12456.00	3.16	4.08
Error (Between)	44	173530.88	3943.88		
Within-Subjects	192	64731.60			
A (Periodic Testings)	4	15264.46	3816.11		
AB (Periodic Test-Calisthenics)	4	336.02	84.01	.33	2.37
AC (Periodic Test-Know of Res)	4	2719.86	679.96	2.63[a]	2.37
ABC (Test-Cal-Know of Res)	4	966.22	241.55	.93	2.37
Error (Within)	176	45445.04	258.21		
Total	239	260886.40			

[a] Significant at .05 level.

TABLE 2.—SUMMARY TABLE FOR TYPE I DESIGN AT LEVEL C_1

Source	d.f.	EX^2	s^2	F	$F_{.95}$
Between-Subjects	23	74538.56			
B (Calisthenics)	1	12362.70	12362.70	4.37[a]	4.30
Error (Between)	22	62175.86	2826.17		
Within-Subjects	96	36610.64			
A (Periodic Testings)	4	14398.20	3599.55	13.94[a]	1.39
AB (Testings-Calisthenics)	4	756.13	189.03	.73	1.39
Error (Within)	88	21456.31	243.82		
Total	119	111149.20			
Error (Within)					
Total Data	176	45445.04	258.21[b]		

[a] Significant at .05 level.
[b] Error term for all data used in determining F ratio.

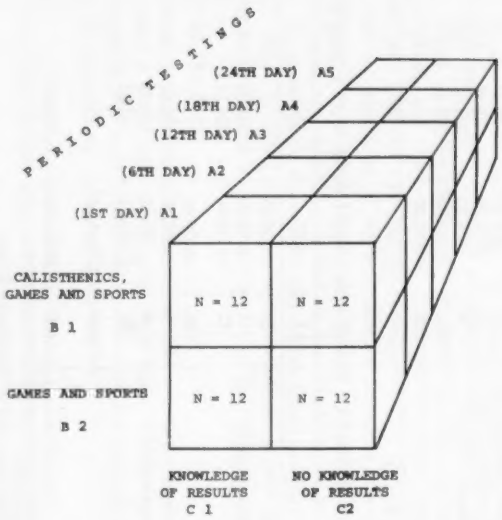

FIGURE I. Pictorial Diagram of Type III Design.

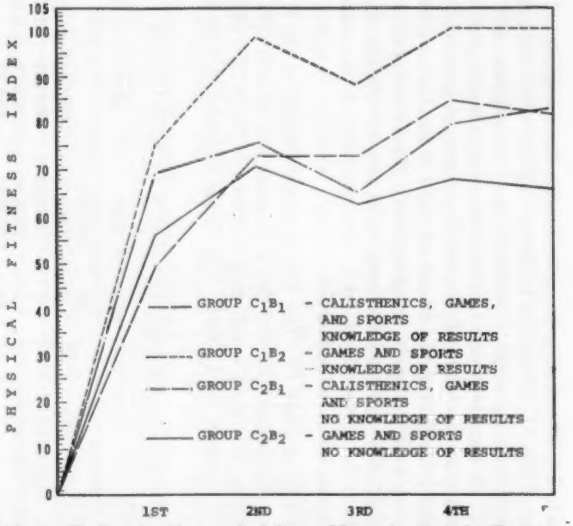

FIGURE II. Graphic Portrayal of Group Means for Periodic Testings.

A critical difference was determined for comparing the A means at the C_1 level on the basis of the following formula:

$$d = 1.96\left(\sqrt{258.21\ (1/24 + 1/24)}\right) = 1.96\ (4.54) = 8.89.$$

If the difference between any two A means at the C_1 level was equal to or greater than 8.89, it was concluded that a significant difference existed.

The mean for each level of A at the C_1 level was calculated, and the results are reported in Table 3. A critical difference table was established which compared the various A means. This critical difference amounted to 8.89 and was established in the manner described in the above formula. Table 4 reveals that several differences were present in the A means. Since the mean for A_1 was smaller than the means for A_2, A_3, A_4, and A_5, as shown in Table 3, it was concluded that providing a knowledge of results had some effect on the physical fitness status of the subjects after the first testing.

Type I Design at Level C_2. In further breaking down the design to locate this AC interaction, it was necessary to run a Type I Design at the C_2 level. The first hypothesis tested at the C_2 level was the one of no AB interaction; this hypothesis was tenable, as indicated in Table 5. The main effects were

TABLE 3.—A MEANS AT LEVEL C_1

A_1	A_2	A_3	A_4	A_5
62.33	86.08	81.25	92.83	91.00

TABLE 4.—CRITICAL DIFFERENCE TABLE FOR A MEANS AT LEVEL C_1

	A_2	A_3	A_4	A_5
A_1	23.75[a]	18.92[a]	30.50[a]	28.68[a]
A_2		4.83	6.75	4.98
A_3			11.58[a]	9.75[a]
A_4				1.83

[a] Significant at .05 level.

TABLE 5.—SUMMARY TABLE FOR TYPE I DESIGN AT LEVEL C_2

Source	d.f.	EX^2	s^2	F	$F_{.95}$
Between-Subjects	23	113530.79			
B (Calisthenics)	1	2176.00	2176.00	.43	4.30
Error (Between)	22	111354.79	5061.58		
Within-Subjects	96	28121.20			
A (Periodic Testings)	4	3690.56	922.64	3.57[a]	1.39
AB (Testings-Calisthenics)	4	441.68	110.42	.43	1.39
Error (Within)	88	23988.96	272.59		
Total	119	141651.99			
Error (Within)					
Total Data	176	45445.04	258.21[b]		

[a] Significant at .05 level.
[b] Error term for all data used in determining F ratio.

then tested. A further inspection of Table 5 reveals that a difference did exist in the A means at the C_2 level. The simple effects of A were then tested.

Inasmuch as the error term for the entire data was used in determining the F ratio at the C_2 level and each A mean consisted of 24 scores, the same critical difference that was used at the C_1 level was valid at the C_2 level. This critical difference was 8.89. The mean for each level of A at the C_2 level was calculated, and the results are reported in Table 6. A critical difference table was established for comparing the various A means at the C_2 level and the results of these comparisons are reported in Table 7.

On the basis of the findings as presented in Table 6, it was concluded that the A mean was smallest initially but did tend to increase as the experiment progressed. A comparison of the differences in the A means at the C_1 level as presented in Table 4 and the differences in the A means at the C_2 level as presented in Table 7, however, indicates that the discrepancies between the means at the C_1 level were markedly larger than the ones at the C_2 level. The practical interpretation of these findings seems to indicate that a knowledge of results facilitated larger gains in physical fitness than did no knowledge of results.

Conclusions

The following conclusions were drawn from the findings of the experiment.

1. Hypothesis 1 was rejected on the basis of the data presented in Table 1. While there was no ABC interaction, there did prove to be an AC interaction. The presence of this interaction seemed to indicate that there was some combination of periods of observations and knowledge of results combining to result in unequal treatment means at the AC level.
2. Hypothesis 2 was rejected, and it was therefore concluded that a knowledge of results did facilitate an increase in physical fitness.
3. Hypothesis 3 was accepted, and it was therefore concluded that physical fitness improvement was not a function of course content.
4. Hypothesis 4 was rejected, and it was therefore concluded that the physical fitness status of the subjects did improve over the experimental period.

TABLE 6.—A MEANS AT LEVEL C_2

A_1	A_2	A_3	A_4	A_5
63.75	74.21	65.21	75.91	76.38

TABLE 7.—CRITICAL DIFFERENCE TABLE FOR A MEANS AT LEVEL C_2

	A_2	A_3	A_4	A_5
A_1	10.46[a]	1.46	12.16[a]	12.63[a]
A_2		9.00[a]	1.70	2.17
A_3			10.70[a]	11.17[a]
A_4				.47

[a] Significant at .05 level.

5. There was no combination of knowledge of results and calisthenics which had any effect on the physical fitness status of the subjects when considered independently of the time factor. Stated statistically this means there was no BC interaction.

6. There was no combination of periods of observations and calisthenics which had any effect on the physical fitness status of the subjects when considered independently of the knowledge of results factor. Stated statistically this means there was no AB interaction.

Recommendations

The author wishes to emphasize that in an exploratory experiment of this kind there are certain limitations. The reader is further reminded that the whole theory of statistical inference is based on probability and that while we never prove anything conclusively we can present circumstantial evidence which seems to justify certain conclusions. There was always the possibility of making an alpha error, and there may also have been trends in the experimental means which were not distinct enough to be detected at the .05 level of significance. Research and experimentation should be conducted with the idea of validating or disproving current theory and thereby improving the quality of instruction.

With the mentioned shortcomings clearly in mind and using the latter two concepts as guidelines, the author feels that perhaps the administrators charged with the responsibility of conducting physical fitness programs might give some consideration to this psychological principle of informing students periodically of their progress or regression. This does not imply that the planned program of calisthenics should be relegated to an inferior place in the curriculum. It does, however, suggest that the two factors (calisthenics and knowledge of results) might be combined and more effectively integrated into the physical fitness program. For, while the results of the study were far from overwhelming and unequivocal, the author feels it safe and statistically sound to make the following statement concerning the findings which emerged from the study.

Of the experimental variables under consideration, knowledge of results seemed to be the most effective for the task of increasing the physical fitness status of the male freshman population at Shepherd College.

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(Submitted 3/7/60)

Notes & Comments

NOTES

Meaning of a Significant t

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ONE OF THE assumptions underlying the application of the frequency theory of probability is the principle of indifference, which states that if we have no means of choosing among several alternatives, they are to be regarded as being equally probable. It is to be expected, then, that if an investigator conducts 100 similar experiments, the results of five of these will be statistically significant at the .05 level by chance alone. With 50 such experiments, at least two can be expected to be significant at this level, and even at the .01 level the chances of retaining a false hypothesis (Type II error) are fifty-fifty, since there is one-half in fifty that a significant item will randomly appear.

A review of the RESEARCH QUARTERLY for 1959 reveals 17 articles which made use of t values and 15 which utilized the coefficient of correlation. Of these, the former were reported an average of 36 times per article (with a median of 30) and the latter 30 times per article. In one instance, 149 t values were listed, of which 26 were said to be significant at the .05 level. The normal expectation is that seven of these would be significant by chance alone. The principle of indifference would seem to preclude the determination of which seven of the 26 were due to pure chance, so the reader's confidence in the conclusions based on these results should, by rights, be reduced by one-fourth. The various samples could be tested to determine if they are from a common population and, if so, lumped together, lessening the number of values to be reported. However, the use of the t might better be reserved for testing theoretically derived hypotheses than used as a shotgun to bring down valid items.

(Submitted 2/15/60)

Research Abstracts

Prepared by the Research Abstracts Committee of the Research Council, D. B. VAN DALEN, Chairman

137. ANDERSEN, K. LANGE; BOLSTAD, ATLE; and SAND, S. "The Blood Lactate during Recovery from Sprint Runs." *Acta Physiologica Scandinavica* 48: 231-37; 1960.

Little evidence is available concerning recovery time for most athletic activities. After running 100 meters pulmonary ventilation reaches resting levels in about 10 minutes. The lactic acid is still very high, which shows that lactic acid does not cause elevated pulmonary ventilation. Recovery after running 200 meters is similar. Blood lactate increases for five to eight minutes after exercise. Thereafter recovery is exponential against time. Recovery time increases as the distances become longer up to about 400 meters; longer runs do not increase the recovery time. The removal of lactic acid from the blood is a slow process. The time interval between two races should be at least long enough to permit recovery from the first run. This means 40 min. between two 100-meter starts and at least 75 min. for the 400- and 800-meter runs.—*Philip J. Rasch, Journal of the Association for Physical and Mental Rehabilitation.*

138. BANDO, E.; KAKAYAMA, T.; MIYAMOTO, H.; USHIKUBO, S., and SASADA, T. "On the Features in the Physical Fitness of the Champions of Weight-Lifting." *Japanese Journal of Physical Fitness* 6: 119-202; January 20, 1957.

Anthropometric measurements were made of 11 weightlifters. It was concluded that those who lift heavy weights have very large and strong backs, great strength in the grip, and great arm power. In these areas the degree of hypertrophy is large. The shoulders and chest are also large in these people, and the body possesses a triangular shape. Probably the reason is that these portions of the body are used to perform the lifts. It may be that this special type of body is due to the long hours of exercise, but further research is needed to determine whether this is characteristic of everybody who does this type of exercise.—*Philip J. Rasch, Journal of the Association for Physical and Mental Rehabilitation.*

139. BRITISH MEDICAL JOURNAL. "Shoes and Feet." 5171: 488-89; February 13, 1960.

Some maintain that but for the effects of unsuitable footwear there would be no foot troubles apart from congenital disease and gross injury. Others believe that many common foot deformities are at least partially determined by inherent weaknesses in the foot. Evidence exists to show that some of the common foot deformities of civilized communities occur also in those who do not wear shoes. Most harm from unsuitable shoes arises during growth. Most observers agree that an excessive number of girls compared with boys have hallux valgus. Lake maintains the most important factor is the wearing of higher heels.—*Philip J. Rasch, Journal of the Association for Physical and Mental Rehabilitation.*

140. BROUHA, LUCIEN. "Effects of Muscular Work and Heat on the Cardiovascular System." *Industrial Medicine and Surgery* 29: 114-20; March 1960.

Muscular exercise may strain the cardiovascular system to its maximum capacity and lead to complete exhaustion. When heat stress is present, the maximum reactions remain the same but are achieved with less work and in shorter time. Heart rate increases as soon as exercise begins, or perhaps even before. Rates of 250 beats per min. have

been recorded after competition. It is considered that at rates over 180 the period of diastole is too short to permit an adequate filling of the heart, but so far as oxygen transport is concerned, the blood circulation remains fully effective at rates in excess of 200.

The "cardiac cost" or total number of heart beats above the resting level needed to perform a given task may be used to compare different work loads. The "cardiac debt" is the number of beats above the resting level occurring between the end of exercise and the return to the pre-exercise rate. This shows a greater variation than the cardiac cost and is an important factor in evaluating the physiological strain produced by muscular work.

During muscular activity the systolic and pulse pressures increase with the work load, while the diastolic pressure changes are insignificant. The most efficient cardiovascular adaptation to muscular activity is achieved when the systolic pressure in mm. Hg. remains numerically greater than the heart rate in beats per minute. At the end of competitive performance systolic pressures of 240-260 mm. Hg. have been recorded in athletes with pulse pressures of 160-180 mm. Hg. As long as the pulse pressure remains constant or increases, muscular work can be pursued efficiently. A decrease of pulse pressure to half of its maximum value indicates fatigue and approaching exhaustion. After exhausting effort the pulse pressure may fall as low as 15-20 mm. Hg. Recovery is not complete until the pressure returns to the pre-exercise level, which may require several hours or days.

During high temperatures, the body temperature rises, accelerating the heart rate and increasing the amount of water lost through perspiration. This partial dehydration puts an additional stress on the cardiovascular system, since the blood volume decreases, the venous return is impaired, and the viscosity of the blood increases.

The cardiac cost and the cardiac debt give a better measurement of the stress of muscular work than does oxygen consumption. Their sum is a measure of the total physiological cost for a complete work cycle. The pulse rate may be counted by hand at regular intervals during the first three minutes of recovery and a recovery curve constructed from these counts.—*Philip J. Rasch, Journal of the Association for Physical and Mental Rehabilitation.*

141. Cantone, A., and Cerretelli, P. "The Effect of Muscular Work on Serum Aldolase Activity in Trained and Untrained Man." *Arbeitsphysiologie* 18: 107-11; January 1960.

After a 30-min. run on a treadmill (8 km/hr, 3% grade), the venous blood was tested for aldolase activity in two subjects (25 yr. old males). The same subjects were again tested after about one week of daily runs. Five subjects trained daily for 50 days (10 km/hr, level) until exhaustion, which occurred within 15-30 minutes. Aldolase activity was tested for the latter subjects at regular intervals during the training period. As a fourth experiment, rugby players were tested before and after a training game.

The authors conclude that the aldolase activity is increased by strenuous exercise and returns to normal within about 75 minutes in untrained subjects. The resting aldolase activity increases during a short training period and returns to normal in two to four days after cessation of this period. The longer training period (50 days) resulted in an aldolase activity which was two to four times higher than after the short training period. No relationship was established between resting serum aldolase activity and serum potassium, or protein level.—*J. Royce.*

142. Eason, Robert G., and White, C. T. "Relationship between Muscular Tension and Performance during Rotary Pursuit." *Perceptual and Motor Skills* 10: 199-210; June 1960.

An investigation was made of the relationships which may exist between muscular tension, as reflected in the surface EMG, and performance during rotary pursuit. In Part

A, 48 Ss were randomly assigned to four groups which received either 40, 20, 10, or 0 sec. rest between trials. After 10 trials, S was given a 10-min. rest and then 10 more trials. In Part B, 22 Ss were randomly assigned to three groups which had either 0-, 5-, or 10-lb. weights suspended from the wrist. While S performed the rotary pursuit task EMG activity was recorded from neck, trapezius, deltoid, and biceps muscles and integrated over 10-sec. intervals within 1-min. trials. Percent time-on-target measures were simultaneously obtained for each 10-sec. interval. Performance was positively related to the length of the intertrial interval and inversely related to physical work load. Opposite relationships were found between the EMG and these two variables. Thus, an inverse relationship was found between EMG level and performance, and was interpreted as evidence that muscular fatigue is partly responsible for the superiority of distributed practice over massed practice. The complex relationships observed between the EMG and performance as a function of amount of practice, and as a result of a 10-min. rest, were explained in terms of a two-factor hypothesis of muscular tension. It states that muscular tension is positively related both to motivation, which facilitates performance, and to muscular fatigue, which is detrimental to performance, and that the tension level at any given time is a summation of the motivation and fatigue components.—*D. B. Van Dalen.*

143. Espinosa, L. Jimenez, and Iborra, J. Espinosa. "Knock-Out and Syncope in Professional Boxing: An Electroencephalographic Study." *Electroencephalography and Clinical Neurology* 12: 196-97; February 1960.

The study of syncopes caused by the oculo-cardiac reflex and the senocarotide reflex has been growing in importance. Whether these crises are similar to epilepsy is controversial. In a study of professional boxers who had been knocked out, a fainting reaction to the oculo-cardiac reflex was discovered. This suggests consequences that may arise from cerebral damage of a vascular type to boxers who have been repeatedly knocked out.—*Philip J. Rasch, Journal of the Association for Physical and Mental Rehabilitation.*

144. Garber, E. D. "Nutritional Aspects of Infectious Disease." *Naval Research Reviews* 9-12; March 1960.

The 19th century's most spectacular contribution to medical science was the discovery of the causes of infectious disease; equally spectacular in this century was the control of these diseases by public health measures and by the use of drugs. Disease inciting microbes are termed pathogens. The host, or animal expressing the disease, is the environment for the pathogen. If the host is resistant it may block the sequence of events leading to the production of the disease. Hence pathogenicity must be expressed as a dynamic host-parasite relationship.

Known sources of resistance do not explain all of the questions about pathogenicity. It is possible that some of these problems will be solved by a study of the nutritional aspects of pathogencity. If a host does not furnish the nutritional requirements of the pathogen, the latter may lose its ability to incite disease. Experiments with plants have disclosed several methods by which a nutritionally deficient pathogen may become nonpathogenic for certain hosts.—*Philip J. Rasch, Journal of the Association for Physical and Mental Rehabilitation.*

145. Hanson, John A., and Jones, F. P. "A 'Color Clock' for Use in Coding Stroboscopic Multiple-Image Photographs." *Perceptual and Motor Skills* 10: 193-94; June 1960.

A method for color coding photographs in recording reaction time and other movements is described.—*D. B. Van Dalen.*

146. JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION. "Boxing and Face Lacerations." *Journal of the American Medical Association* 172: 1116; March 5, 1960.

The ideal medicament to be applied during a bout to a facial laceration sustained by a boxer is a matter of controversy. Monsell's, ferric chloride, and epinephine solutions, various pastes, and such ointments as bismuth subgallate, zinc oxide, tannic acid, and carpenter's glues are used but are to be condemned. Topically applied thrombin or any approved thromboplastic substance appear to be the most effective coagulants and least injurious to the wound. Sterile petroleum jelly can be used but should be removed immediately after the fight. Ice or water compresses may be useful adjunctive aids.—*Philip J. Rasch, Journal of the Association for Physical and Mental Rehabilitation.*

147. MACNAMARA, J.; PRIME, F. J.; and SINCLAIR, J. D. "The Increase in Diffusing Capacity of the Lungs on Exercise." *Lancet* 7121: 404-406; February 20, 1960.

When oxygen is taken up by the alveoli of the lungs it penetrates the mechanical barrier of the tissue elements and fluids separating it from the molecules of hemoglobin in the red blood cells by a process of simple physical diffusion. The diffusing capacity is proportional to the area of the diffusing surface and varies inversely with its thickness. Normal rates are 15-25 ml. per min. per mm. Hg. at rest and 24-40 ml. during exercise. An earlier study showed that this rate is significantly affected by the minute volume of respiration, and that the exercise rate cannot be duplicated by voluntary hyperventilation. It was concluded that the pulmonary diffusing capacity observed during exercise is due primarily to an increase in the area of capillary wall exposed to alveolar gas. This is mediated partly by hyperventilation and partly by increased cardiac output during exercise.—*Philip J. Rasch, Journal of the Association for Physical and Mental Rehabilitation.*

148. SLOAN, A. W. "A Modified Harvard Step Test for Women." *Journal of Applied Physiology* 14: 985-86; November 1959.

A standard version of the Harvard step test was administered to a control group consisting of 46 male medical students. One standard and 2 modified versions of the same test were administered to an experimental group of 15 female physiotherapy students. In the modified versions, stepping-stools of 18 and 16 inches high were used; all other conditions were standard. The tests took place on different days, and their order was staggered. The mean fitness index of the men was found to fall between the mean index of the women stepping 18 inches and that of the women stepping 16 inches.

Subsequently, another experimental group composed of 16 female medical students took modified versions of the test in which stepping-stools with heights of 18, 17, and 16 inches were used. As before, all other conditions were kept standard and the order of administration was staggered. The closest agreement with the man of the male control group was found at 17 inches. Upon further analysis of the data, it was found that the distribution of individuals from each group in the several categories of physical fitness also corresponded significantly. It was concluded that a suitable height of step for women performing the Harvard step test is 17 inches, and at this height the same arbitrary standards of performance used for men on a 20-inch step may be applied.—*Carl S. Blyth* and *W. C. Taylor, Jr.*

149. SMIRNOV, K. M., and others. "Effect of Competitive Conditions on Respiratory Exchange, Pulse Rate, Arterial Pressure, and Efficiency in Athletes." *Sechenov Physiological Journal of the U.S.S.R.* 45: 273-78; 1959.

Cannon attempted to explain the mechanism of the effects of competitive conditions on the athlete by attributing it to increased secretion of adrenalin. Physiologists now study the competitive setting as a conditioned reflex. Prestart reactions may increase the power to respond by excitation and to react to the operating stimulus. This suggests training increases the potential efficiency of the nerve cells in the strength of their excitatory

process as a result of regular reinforcement. Training activities always contain some elements of competition and these should be regarded as conditioned reflex stimuli connected with the exercises.

Improvement in achievements during particularly important appearances occurred only in individuals possessing strong excitatory processes. High prestart reactions were shown by individuals with a high degree of efficiency under such conditions. Reactions to competitive conditions are more pronounced in adolescents than in adults. Systematic training did not reduce these differences, and, in some cases, imparted an additional increase to adolescent reactions. Prework changes were more pronounced in young athletes than in nonathletes.

In competition prestart reactions are more pronounced than in the laboratory. Perhaps this results from the secretion of adrenaline and adrenocortical hormone under conditions of competition, suggesting that conditioned reflex reactions are rendered more complex in their effector link under conditions of competition by the increased activity of the endocrine glands. This aspect of functional regulation is almost unstudied. (Translated by R. Crawford)—*P. J. Rasch, Journal of the Association for Physical and Mental Rehabilitation.*

150. STEPANOV, A. S. "Electrogram Changes Produced by Training in Weight Lifting." *Sechenov Physiological Journal of the U.S.S.R.* 45: 115-21; 1959.

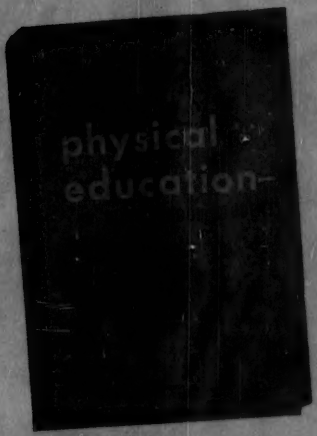
Changes in the motor apparatus appear as the result of constant practice in lifting; a press by a top grade athlete is accompanied by less electrical activity in the muscles than by one in the junior grade. Frequency and amplitude of action potentials decrease as training progresses. The differences in EMGs are not sufficient to explain the difference in the force developed. Apparently they are more closely related to state of training than to degree of attainment. Weaker impulses from the central nervous system become capable of causing a contraction of the same strength as at the beginning of the training period. The mechanisms for the coordination of motor unit activity develop and their capacity for synchronous activity during development of maximum muscular tension is improved. (Translated by R. Crawford)—*P. J. Rasch, Journal of the Association for Physical and Mental Rehabilitation.*

151. TIGYI, J., and SEBES, T. A. "The Coefficient of Temperature and Volume Diminution of the Muscle and Myosin Threads When Passively Stretched." *Acta Physiologica of the Academiae Scientiarum Hungaricae* 16: 123-27; 1959.

When the excised gastrocnemius of the frog is passively stretched, the coefficient of temperature and volume diminution of the muscle and myosin threads is about 1. The authors claim that this substantiates their opinion that second phase volume diminution by means of passive stretching is caused by the crystalization of albumen molecules.—*P. J. Rasch, Journal of the Association for Physical and Mental Rehabilitation.*

152. TWOMBLY, GEORGE, JR. "Physical Medicine in Treatment and Rehabilitation of Arthritis." *Clinical Medicine* 6: 1345-48; August 1959.

The main objectives of physical medicine in the treatment of arthritis are to relieve pain, increase and maintain range of motion of the involved joints, relieve secondary fibrositis and myositis, and improve function and independence. Heat is indicated to improve local circulation, relieve pain, and as a preliminary to massage and exercise. The mildest form of heat than can be tolerated and yet achieve therapeutic results should be used. Massage may be administered to the soft tissues surrounding a joint to alleviate pain and spasm. Exercise can contribute more than any other form of physical treatment. The type, amount, and technique should be specified. The patient may not understand the exercise regimen and instruction should be provided. Under-exercise may contribute to loss of joint motion; over-exercise may result in joint damage. Slight pain may follow exercise; if it persists for more than a day, the exercise is probably too severe.—*P. J. Rasch, Journal of the Association for Physical and Mental Rehabilitation.*



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